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ENGINEERING DESIGN STUDY PLAN
ACCRA PAC/WARNER BAKER SITE
CONSENT DECREE
CIVIL ACTION NO. H89-0113

OCTOBER 20, 1993

PREPARED FOR
ACCRA PAC, INC.
ESTATE OF WARNER BAKER

PREPARED BY
EIS ENVIRONMENTAL ENGINEERS, INC.
1701 NORTH IRONWOOD DRIVE
SOUTH BEND, INDIANA

H. Stephen Nye, P.E.
President

Daniel W. Akin, P.E.-L.S.
Senior Design Engineer

John R. Wingard, P.E.
Senior Engineer

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ENGINEERING DESIGN STUDY PLAN

This Engineering Design Study Plan is submitted in accordance with the provisions of the Civil Action No. H89-0113, Consent Decree lodged with the United States District Court for the Northern District of Indiana, South Bend Division. More specifically, it is the document submitted by Accra Pac, Inc., and Kenneth R. Everett and Diane Lee Power, the personal co-representatives of the Estate of Warner Baker pursuant to Paragraphs 11.a and 11.b of the Consent Decree.

The Engineering Design Study Plan includes plans and schedules for Predesign and Design Tasks identified in the Scope of Work (SOW). The Predesign and Design Tasks identified in the SOW include but are not limited to the following.

- Design Sampling and Analysis (S&A) Plan to include a Quality Assurance Project Plan (QAPP).
- Treatability Studies of Alternatives for Soil Remediation, Groundwater Remediation and Air Emission Remediation.
- Predesign Work Plan.
- Preliminary Design Submittal.
- Final Design Submittal.
- Construction Quality Assurance Project Plan (CQAPP).
- Schedule for Completion of Work.

These plans and schedules are to be submitted to the EPA and the State of Indiana within 60 days of the lodging of the Consent Decree.

The following submittals are also required within 60 days of the lodging of the Consent Decree.

- Health and Safety Plan for Field Design Activities.

- Draft Sampling and Analysis Plan for Multi-Compound Residuals.

PREDESIGN WORK PLAN

1.0 INTRODUCTION

The Predesign Work Plan outlines the work required to provide the Preliminary Design Submittal as required by the Scope of Work (SOW). The Predesign Work Plan includes the following tasks to allow for the selection of the soil, groundwater and air emission remediation technologies and the preliminary design of the remedial action (RA).

- Project Management and Staffing.
- Treatability Studies.
- Remedy Selection and Rationale.
- Establish Preliminary Design Criteria and Specifications.
- Determine Operation and Maintenance Requirements and Costs.
- Preliminary Construction Costs.
- Additional Field Studies.
- Disposal of Predesign Residual Waste.
- Permits and Regulatory Requirements.
- Access, Easement and Right-of-Way Requirements.
- Installation of Additional Monitoring Wells.
- Schedule for Completion of Work.

2.0 PROJECT MANAGEMENT AND STAFFING

2.1 Project Flow Chart

Figure 2.1 provides the Project Flow Chart for the Remedial Design/ Remedial Action (RD/RA) activities.

2.2 Project Coordinators

The Consent Decree has identified H. Stephen Nye, P.E. of EIS Environmental Engineers, Inc. as the Project Coordinator and John R. Wingard, P.E., of EIS Environmental Engineers, Inc. as Alternate Project Coordinator for Accra Pac, Inc. and the co-representatives of the Estate of Warner Baker. Kenneth Theisen of the Emergency and Enforcement Response Branch has been identified as Project Coordinator for the EPA.

2.3 Project Management

The EIS Project Coordinator will be responsible for project planning and oversight. The Project Manager will be responsible for maintaining the project schedule, reporting and staff scheduling. The Project Manager will also function as the Alternate Project Coordinator. The Engineering Manager will be responsible for the implementation of the tasks required to prepare the Preliminary and Final Design submittals.

Figure 2.2 provides a Project Organization Chart.

ACCRA PAC SITE
REMEDIAL DESIGN/REMEDIAL ACTION
PROJECT FLOW CHART

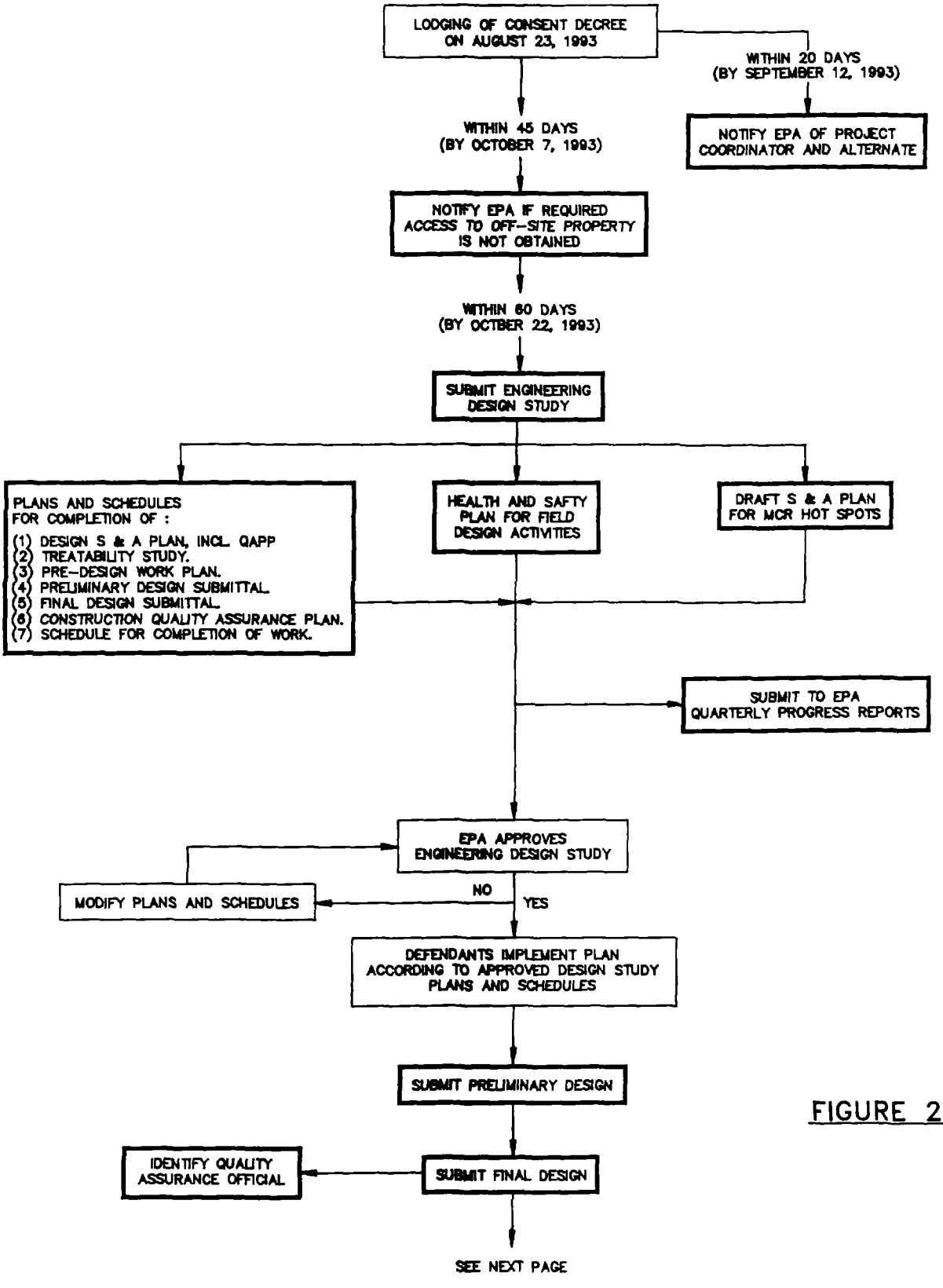
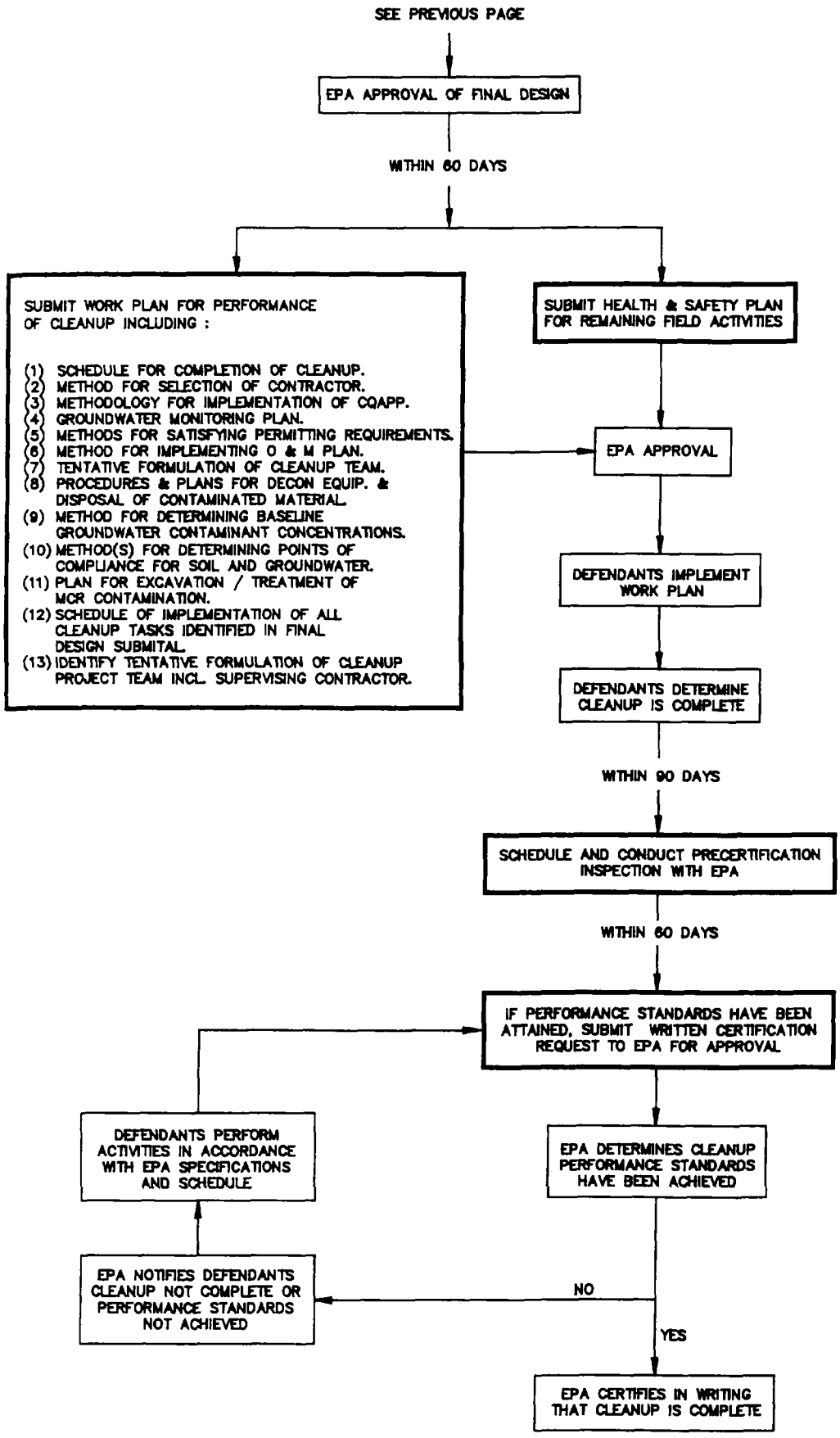


FIGURE 2.1

SHEET 1 OF 2

PROP1



SHEET 2 OF 2

PROP2

PROJECT ORGANIZATION
ACCRA PAC/WARNER BAKER SITE
REMEDIAL DESIGN PHASE

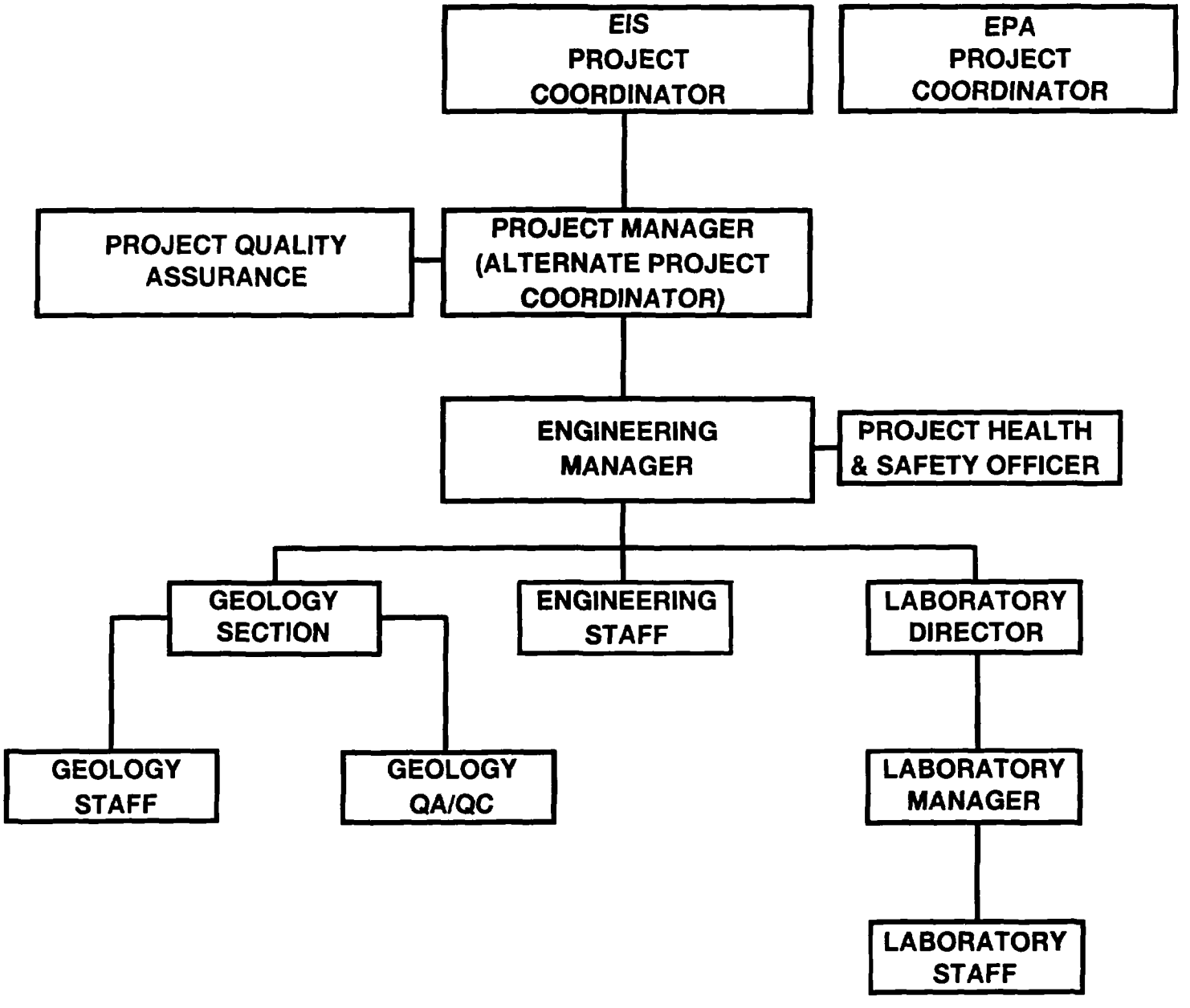


Figure 2.2

2.4 *Project Staffing*

Project staff will include EIS engineers, geologists, chemists as well as health and safety staff, laboratory staff and departmental QA/QC officers.

2.5 *Required EPA Notifications*

Table 2.1 provides a listing of activities or conditions which require notification be made to the EPA.

TABLE 2.1
ACCRA PAC/WARNER BAKER SITE
REQUIRED EPA NOTIFICATIONS

- **OUT-OF-STATE WASTE SHIPMENT**

  Prior to any offsite shipment of waste material to out-of-state facility when total volume exceeds 10 cubic yards for all such shipments. Notice to EPA Project Coordinator and appropriate State Environmental Official (Page 18).

- **SAMPLE COLLECTION**

  Notify not less than 28 days in advance of any sample collection activity (Page 20).

- **ACCESS AGREEMENT**

  Promptly notify if any access required to complete the work is not obtained within 45 days of lodging of Consent Decree (i.e. by October 7, 1993) (Page 22).

- **SCHEDULE CHANGE**

  Notify of any change in the schedule described in the quarterly progress report for the performance of any activity no later than seven days prior to the performance of the activity (Page 24).

- **CERCLA 103 OR EPCRA 304 REPORTING**

  Notify EPA Project Coordinator within 24 hours of the onset of any event during the performance of the work that defendants are required to report pursuant to Section 103 of CERCLA or Section 304 of EPCRA. Submit written reports within 20 days of onset and 30 days of conclusion of such an event (Page 24 and 25).

- **PRE-CERTIFICATION INSPECTION**

  Notify of schedule for pre-certification inspection which is to be conducted within 90 days after defendants conclude that the cleanup has been fully performed (Page 29).

- **EMERGENCY RESPONSE**

  Immediately notify of any event during the performance of the Work which causes or threatens a release of waste material that constitutes an emergency situation or may present an immediate threat to public health or welfare of the environment (Pages 31 and 32).

3.0 TREATABILITY STUDIES

3.1 Purpose

Treatability studies aid in the selection and implementation of appropriate site remediation technologies. The studies will serve to evaluate the feasibility and effectiveness of alternative soil, groundwater and air emission remediation systems; evaluate whether an air emission system is required by federal or state "Applicable or Relevant and Appropriate Requirements" (ARARs); and identify which alternative(s) can be expected to meet the cleanup goals for the site. They will also define the design and operating parameters for each remedial technology that will be required to successfully remediate the site.

A substantial amount of data on remedial alternatives was generated, evaluated and reported as part of the EIS investigation of contamination at the Accra Pac site. The Scope of Work as set forth in the Consent Decree requires a re-evaluation of the effectiveness and implementability of those and other alternatives in meeting the performance standards set forth in the Consent Decree. In addition, the remedial alternatives must comply with "applicable or relevant and appropriate requirements" (ARARs) as set forth in Section 121(d) of CERCLA and any applicable regulations. These treatability studies will also provide the detailed design, cost and performance data required to optimize the treatment processes and to implement the full scale treatment system.

Because there may be different treatment technologies required for the groundwater, soil and air emissions a coordinated effort will be required to optimize the entire treatment system.

3.2 *Implementation Plans*

The evaluation of the soil and groundwater remediation alternatives will be performed by reviewing, updating and supplementing the remedy screening previously performed by EIS as documented in the September 1990 EIS "Report of the Investigation of Contamination at the Warner P. Baker/Accra Pac Site, Elkhart, Indiana."

The general procedures to be used will follow the guidelines presented in the USEPA publication "Guide for Conducting Treatability Studies Under CERCLA", EPA/540/R-92/971a. The tiered approach to be used for the treatability studies is illustrated on the decision tree diagram in Figure 3.1. A description of the treatability studies follows.

3.2.1 Technology Prescreening

The technology prescreening will consist of collection and evaluation of information on the remedial technologies reviewed in the 1990 EIS report and other technologies which have emerged since that time. This information will be obtained by searching literature such as the Superfund Innovative Technology Evaluation (SITE) program technology profiles and Superfund Treatability Clearinghouse Abstracts. Information will also be obtained from electronic databases such the Alternative Treatment Technology Information Center (ATTIC), Oswer Electronic Bulletin Board System and RREL Treatability Database. Technology experts such as those at the USEPA Robert S. Kerr Environmental Research Laboratory and Risk Reduction Engineering Laboratory would be consulted as needed.

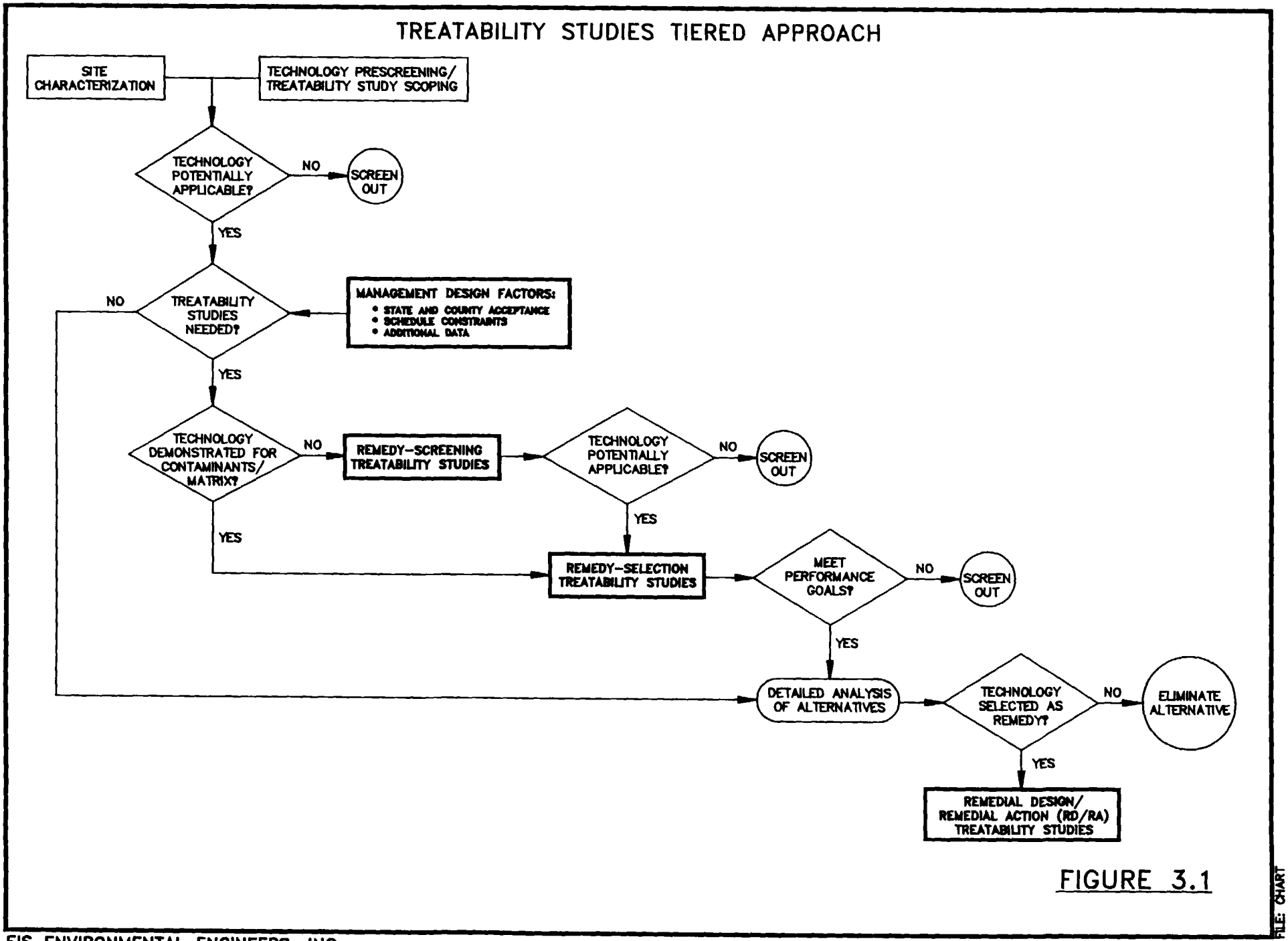

TREATABILITY STUDIES TIERED APPROACH
SITE CHARACTERIZATION
TECHNOLOGY PRESCREENING/ TREATABILITY STUDY SCOPING
TECHNOLOGY POTENTIALLY APPLICABLE?
NO
SCREEN OUT
YES
TREATABILITY STUDIES NEEDED?
NO
MANAGEMENT DESIGN FACTORS:
• STATE AND COUNTY ACCEPTANCE
• SCHEDULE CONSTRAINTS
• ADDITIONAL DATA
YES
TECHNOLOGY DEMONSTRATED FOR CONTAMINANTS/ MATRIX?
NO
REMEDY-SCREENING TREATABILITY STUDIES
TECHNOLOGY POTENTIALLY APPLICABLE?
NO
SCREEN OUT
YES
YES
REMEDY-SELECTION TREATABILITY STUDIES
MEET PERFORMANCE GOALS?
NO
SCREEN OUT
YES
DETAILED ANALYSIS OF ALTERNATIVES
TECHNOLOGY SELECTED AS REMEDY?
NO
ELIMINATE ALTERNATIVE
YES
REMEDIAL DESIGN/ REMEDIAL ACTION (RD/RA) TREATABILITY STUDIES

FIGURE 3.1

The collected information will be used to evaluate which technologies are potentially applicable to the Accra Pac site and, for these technologies, to determine if further treatability studies are needed. If further studies are deemed necessary for particular technologies, the scope of further treatability studies would then be defined. No further studies may be necessary for those technologies which have sufficient data available to permit a detailed analysis for remedy selection.

3.2.2 Remedy Screening

If the technology prescreening indicates that certain remedial alternatives may be technically and economically feasible but have not been demonstrated for the contaminants and/or matrices involved in the Accra Pac site, remedy screening treatability studies may be considered. These studies would be bench scale tests to generate qualitative data which could be utilized to screen out technologies that are not effective for the site specific conditions. Typically these studies would consist of a single set of analyses to determine contaminant concentrations before and after treatment. A technology specific work plan for each remedy screening treatability study would be developed to define the objective, design and procedures, equipment and materials to be used, sampling and analysis requirements, residuals management, schedule and budget.

3.2.3 Remedy Selection

If the technology prescreening or remedy screening indicates that certain technologies are feasible for the site-specific conditions but there is insufficient data to determine if they could meet the required performance standards,

remedy selection treatability studies may be considered. These studies would be bench, pilot, or full-scale tests to generate quantitative performance and cost data under site conditions to permit a detailed analysis of these technologies and whether they could meet the site cleanup criteria. Typically these studies would involve duplicate or triplicate sets of analyses to obtain high quality data on the relationship between site conditions, process parameters and contaminant concentrations; characterization of residuals and products; and capital, operating and maintenance costs. A technology specific work plan for each remedy selection treatability study would be developed to define the elements described above for the remedy screening work plan.

3.2.4 Remedial Design/Remedial Action (RD/RA)

For the selected technologies, the necessity of RD/RA treatability studies will be considered. Most RD/RA studies are performed in the field with pilot or full scale equipment to produce quantitative scale-up design and cost data for implementation of the remedial actions. Typically these studies are performed to select among multiple vendors and processes or to optimize the treatment process design and the costs associated with the remedial action implementation. Such studies are costly and may not be necessary for well-proven technologies. If such studies are deemed appropriate, a technology specific work plan for each RD/RA treatability study would be developed to define the elements previously described.

3.3 *Treatability Study Protocol*

The general protocol to be used for conducting treatability studies includes the following elements ("Guide for Conducting Treatability Studies Under CERCLA", EPA/540/R-92/071a).

- Establishing data quality objectives.
- Identifying sources for treatability studies.
- Issuing the work assignment.
- Preparing the work plan.
- Preparing the sampling and analysis plan.
- Preparing the health and safety plan.
- Conducting community relations activities.
- Complying with regulatory requirements.
- Executing the study.
- Analyzing and interpreting the data.
- Reporting the results.

3.4 *Air Emission Treatability Studies*

With respect to air emission remediation systems, EIS will review Indiana and Federal air emission regulations which might be "applicable" or "relevant and appropriate" (such as 326 IAC 2, 326 IAC 8-1-6, and 40 CFR 264.1031 Subpart AA) and evaluate which, if any, federal and/or state standards are "Applicable or Relevant and Appropriate Requirements" (ARARs) for control of air stripper or other remedial system air emissions. The feasibility and effectiveness of alternative air emission remediation systems will be evaluated using the general treatability guidelines outlined above. The technology prescreening will include a search of literature such as the USEPA

handbooks "Control Technologies for Hazardous Air Pollutants" (Document EPA/625/6-91/014) and "OAQPS Control Cost Manual" (Document EPA/450/3-90-006). Technology experts may also be consulted. If an air emission remediation system is necessary, it is anticipated that a well-proven technology would be utilized. Consequently, it is not anticipated that remedy screening, remedy selection or RD/RA treatability studies would be necessary for the air emission remediation systems.

4.0 REMEDY SELECTION AND RATIONALE

The selection of technology for remedial action will be based on the ability to; (1) meet the performance standards set forth in the scope of work (SOW), (2) comply with applicable or relevant and appropriate requirements, and (3) maintain reasonable capital and operation and maintenance (O&M) costs of a full scale system. The performance standards set forth in the SOW are:

- Groundwater - 95% reduction of the existing baseline concentration of total Volatile Organic Compounds (VOC) at each compliance point.

- Soil - Reduction of the total of the concentration of the 15 VOCs identified in Table 7.2 of the EIS study to 1 ppm.

- Reduction of the multi-component residual (MCR) to a concentration of 1 ppm.

5.0 ESTABLISH PRELIMINARY DESIGN CRITERIA AND SPECIFICATIONS

The data from the treatability studies for the selected remedies will be used to develop the preliminary design criteria and performance data. This would include a site plan with preliminary layouts of equipment which will be utilized along with preliminary process

flow schematics. Preliminary specifications would be developed which when finalized would be used to solicit bids from technology vendors or contractors.

The Preliminary Design Submittal will be completed and will include, at a minimum, the following:

- Design criteria.
- Results of treatability studies.
- Results of additional field sampling and predesign work.
- Project delivery strategy.
- Preliminary plans, drawings and sketches.
- Required specifications in outline form.
- Preliminary construction schedule.

This will be submitted to the EPA and the State of Indiana.

6.0 DETERMINE OPERATION AND MAINTENANCE REQUIREMENTS AND COSTS

Estimates of O&M requirements for each of the selected remedies may include evaluation of these components:

- Operating Labor - Including wages, benefits, training for post-construction by skill categories.
- Maintenance materials and labor - Including labor, parts, and other materials to perform routine maintenance of facilities and equipment.
- Chemicals and Utilities - Treatment and maintenance chemicals, gas, electric, telephone, water and sewer services.
- Purchased Services - Sampling and analytical laboratory fees and other professional services.
- Administrative Costs - Costs associated with administration of the remedial action O&M not included under other categories.
- Insurance, Taxes, Licenses - Includes liability and accident insurance; licensing for certain technologies; permit renewal and reporting costs.
- Maintenance Reserve and Contingency Costs - Includes annual payments into escrow fund to cover anticipated replacement or rebuilding of equipment and any large unanticipated O&M costs.

7.0 ADDITIONAL FIELD/LABORATORY STUDIES

7.1 General

The additional field studies required at this time include: identifying the compounds designated as Multi-Component Residuals (MCR) in the EIS investigation report; determining whether a subsurface structure exists along the east side of the property

and whether it is a contamination source; static water level measurements; determine the presence or absence immiscible dense nonaqueous phase liquids (DNAPLs); the installation of additional monitoring wells. All field and laboratory work will be conducted in accordance with the Sampling and Analysis Plan.

7.1.1 Multi-Component Residuals

The compounds identified as MCR are unknown hydrocarbons. There are two small areas of high concentrations (hot spots) which the SOW requires to be investigated. The initial analysis of the compounds indicated that they were not listed as hazardous waste in 40 CFR Part 261 nor were they listed as parameters in 40 CFR Part 264, Appendix IX - Groundwater Monitoring List. If halogenated compounds are not co-resident with the MCR, the hot spots may be excavated and disposed in a landfill as a special waste. Soil samples from the hot spots will be analyzed for Volatile Organic Compounds and Semi-Volatile Organic Compounds.

7.1.2 Unidentified Concrete Structure

Along the east side of the property between the locations of MW-9 and B-19 there exists a large concrete pad with an adjacent steel pipe exiting the ground. It has not been determined whether a subsurface structure, possibly a tank, is located beneath the concrete pad. It is possible that a tank or other vessel such as a cooling tower was located on the pad and the contents were pumped from the tank or equipment through the steel pipe. This structure is located near the center of the groundwater contaminant plume.

7.1.3 Static Water Level and DNAPLs

The present groundwater flow direction will be determined early in the predesign phase for correlation with the determinations made in early 1990. In addition tests will be conducted in the existing monitoring wells to determine whether immiscible liquids, more specifically, dense nonaqueous phase liquids (DNAPLs) are present. It is critical to make this determination prior to design because the presence of DNAPLs can affect the success in meeting the performance standards.

7.1.4 Installation of Additional Monitoring Wells

The installation of additional groundwater monitoring wells may be required at several locations where the presence of dense nonaqueous phase liquids (DNAPLs) is suspected.

In addition, several more wells may be installed at locations where significant contamination is present at depths beyond the existing well screens. This will require nesting of the additional wells.

8.0 DISPOSAL OF PREDESIGN RESIDUAL WASTE

8.1 Initial Field Investigation

Residual waste that was generated during the initial field investigation was stored in the concrete loading dock ramp located near the southeast corner of the former building slab. This waste includes drill cuttings which were placed in the north end of the ramp.

Drums of disposable equipment and protective gear are also located in the ramp. The drums were labeled in accordance with 40 CFR Part 262.

8.2 *Predesign Field Activities*

All residual waste that is generated onsite during the predesign activities, including treatability studies, that will require offsite disposal will be containerized and labeled in accordance with 40 CFR Part 262.

8.3 *Offsite Treatability Study Residuals*

Waste that may be generated at an offsite laboratory or testing facility may be returned to the sample originator under the Federal Treatability Study Sample Exemption Rule if the storage time limits in 40 CFR 261.4(f) are not exceeded.

If the exemption does not apply, the disposal of treatability study residuals is subject to appropriate regulations, including RCRA land disposal restrictions for contaminated soils and debris.

8.4 *Offsite Treatment/Disposal*

All residual waste that require offsite treatment and/or disposal will be packaged, labeled and manifested in accordance with 40 CFR 262 and applicable DOT regulations for hazardous materials under 49 CFR Part 172.

9.0 PERMITS AND REGULATORY REQUIREMENTS

9.1 Onsite Activities

Any portion of the work conducted onsite under CERCLA may be conducted without any Federal, State or Local permits [40 CFR 300.400(e)(1)]. Such studies must comply with ARARs under Federal and State laws. Any air or water emission generated under this exemption will meet applicable emission or discharge limits.

9.2 Offsite Activities

Any offsite facility that receives waste from the site must be in compliance with applicable Federal and State laws and must control any relevant releases of hazardous substances to the environment.

Offsite treatability studies under CERCLA must be conducted under appropriate Federal or State permits and meet other legal requirements. The treatability exclusion under RCRA may exempt small-scale offsite testing activities from certain RCRA permitting requirements.

If offsite studies are required, compliance of the offsite facility with appropriate permit or regulatory requirements will be verified.

10.0 ACCESS, EASEMENTS AND RIGHT-OF-WAY REQUIREMENTS

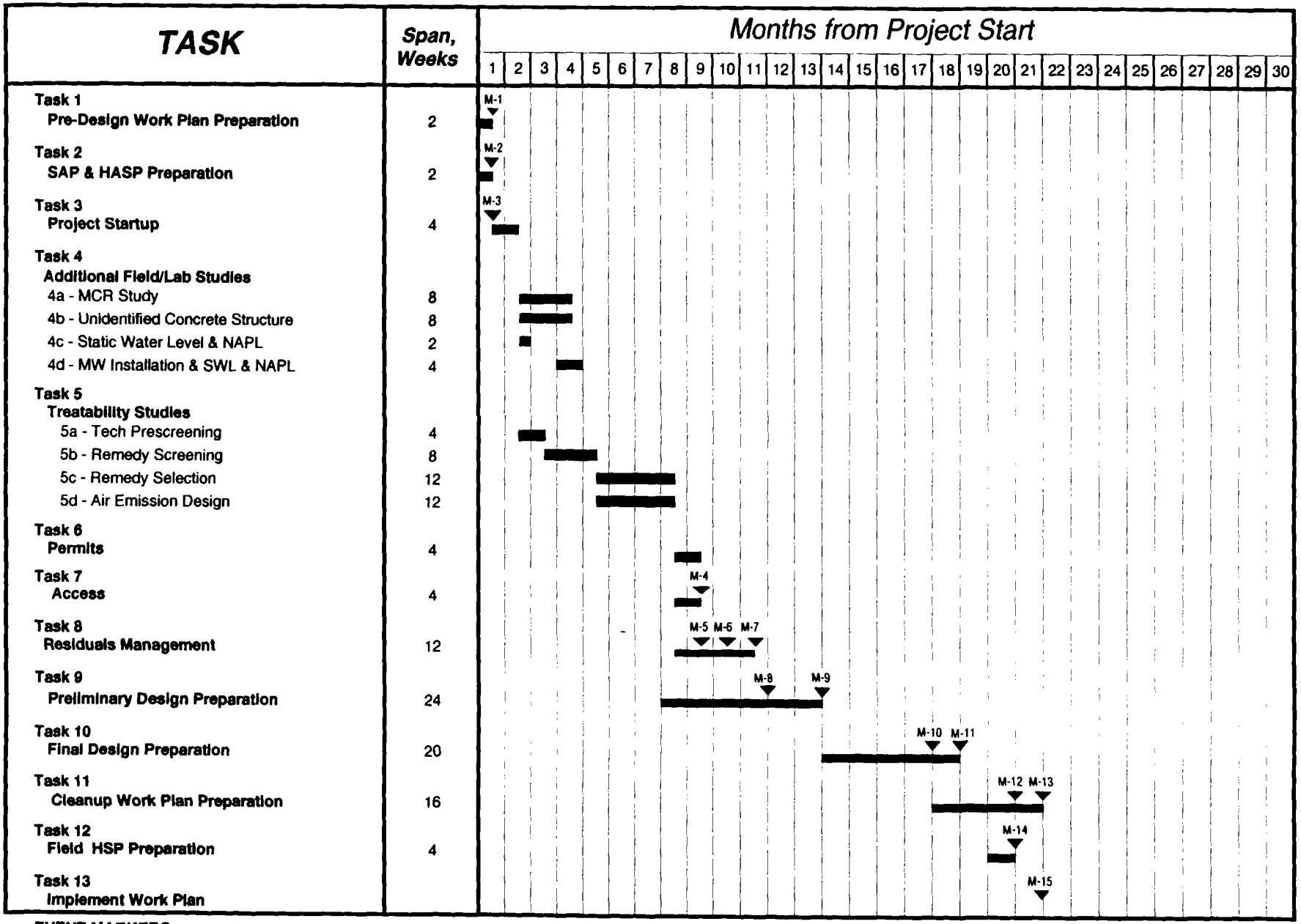
Once the remedial technologies have been selected, a determination will be made regarding the need for access to offsite property. This access may be required for installation of above ground equipment or subsurface wells or piping. Access to the

property located adjacent to the east property line of the Site belonging to ADEC will be required. Initial discussions with ADEC indicate that they will grant access if the operation of their business is not disrupted and there are no hazards to their employees safety. At this time it is not known whether access will be required to other private or municipal property.

11.0 PROJECT SCHEDULE

The Project Schedule as indicated on Figure 11.1 is a preliminary estimate of the time that will be required for the completion of each of the tasks identified in Section 1.0. The time required to complete the tasks for the project through initiation of construction are also presented.

Because the remedial technologies have not yet been selected, these time estimates should be used with caution. The time schedule will be updated as the project progresses to maintain its accuracy within reasonable limits.



EVENT MARKERS

M-1 Work Plan Approval	Wk 2	M-8 Submit Preliminary Design	Wk 48	M-15 Begin Work Plan Implementation	Wk 88
M-2 SAP & HASP Approval	Wk 2	M-9 Preliminary Design Approval	Wk 56		
M-3 Authorization to Proceed	Wk 2	M-10 Submit Final Design	Wk 72		
M-4 Sign Access Agreement	Wk 38	M-11 Final Design Approval	Wk 76		
M-5 Submit Disposal Application	Wk 38	M-12 Cleanup Work Plan Submittal	Wk 84		
M-6 Disposal Approval	Wk 42	M-13 Cleanup Work Plan Approval	Wk 88		
M-7 Ship Waste for Disposal	Wk 46	M-14 Field HSP Submittal	Wk 84		

1092-6154-93 SCHEDULE.XLS

Figure 11.1 - Accra Pac Site Project Schedule Predesign to Work Plan Implementation

APPENDIX A

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN
ACCRA PAC/WARNER BAKER SITE
ELKHART, INDIANA
CONSENT DECREE
CIVIL ACTION NO. H89-0113

OCTOBER 20, 1993

PREPARED FOR
ACCRA PAC, INC.

PREPARED BY
EIS ENVIRONMENTAL ENGINEERS, INC.
1701 NORTH IRONWOOD DRIVE
SOUTH BEND, INDIANA

Andris Rozite, Vice President &
Laboratory Director

CONTENTS

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared in accordance with the provisions of the Consent Decree No. H89-0113 lodged with the United States District Court for the Northern District of Indiana, South Bend Division. This plan is meant to comply with items identified in the Predesign and Design Tasks of the Consent Decree Scope of Work (SOW). As such, this SAP consists of both a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

The SOW requires the investigation of various Remedial Technologies for soil, groundwater and air emission contaminant reduction to achieve SOW specified cleanup levels. Included in the investigation is the potential for soil excavation in certain designated (limited) areas of the site. The specific Remedial Technologies have not been selected nor has the soil excavation alternative been evaluated.

This SAP is intended to be a single source, updateable document to meet the following two objectives:

- To provide guidance for all field work by defining the sampling and data gathering procedures.

  This objective will be met by a process of updating, as required, the Field Sampling Plan (FSP) to reflect project (technology) specific requirements not present in the existing plan.

- To describe the policy, organization and quality assurance/quality control protocols necessary to achieve the data quality objectives.

This objective will be met by a process of updating the Quality Assurance Project Plan (QAPP) to reflect project (technology) specific requirements not present in the existing plan.

The anticipated process to generate and distribute either FSP or QAPP updates is presented in Section 1.2.

1.1 Site Background

In December 1986, an Administrative Order was issued to Warner P. Baker to remove, transport and dispose of the tanks and the tank contents. Weston SPER, a USEPA Contractor monitored this activity. In addition, Weston SPER installed three groundwater monitoring wells onsite and one well offsite to the south of the property. Samples from these wells indicated the presence of groundwater contamination.

In March 1988 the EPA issued an Administrative Order to Accra Pac, Inc. which provided that the nature and extent of the remaining soil and groundwater contamination at the site be determined.

In September 1990, Accra Pac, Inc. and the Estate of Warner P. Baker submitted to the EPA, a "Report of the Investigation of Contamination at the Warner P. Baker/Accra Pac Site". This report was prepared by EIS Environmental Engineers, Inc.

This Sampling and Analysis Plan (SAP) has been prepared in accordance with the provisions of Civil Action No. H89-0113, Consent Decree lodged with the United States District Court for the Northern District of Indiana. The SAP is part of the Engineering Design Study Plan and will be utilized during the execution of the Predesign and Final Design tasks.

1.2 *Sampling and Analysis Plan Updates*

The original version of this document will be considered Revision 0.0. This version will incorporate generic field sampling techniques as well as broad range laboratory operating protocols.

Updates to either the Field Sampling Plan (FSP) or the Quality Assurance Project Plan (QAPP) to accommodate technology specific sampling/laboratory protocols will be made as follows:

- Revisions to the FSP will sequentially increase the digit to the left of the decimal point in the SAP Revision Number.

  The first FSP revision will then be indicated as follows: SAP Rev. 1.0 (date).

- Revisions to the QAPP will sequentially increase the digit to the right of the decimal point in the SAP Revision Number.

  The first QAPP revision will then be indicated as follows: SAP Rev. 0.1 (date).

- The SAP Revision Number will thus track both FSP and QAPP revisions. Two (2) FSP and three (3) QAPP revisions, necessitated by technology changes, will thus be evident as follows: SAP Rev. 2.3 (date).

Updates to the SAP which will require revision changes will be defined as those needed to accommodate new field sampling requirements or different laboratory analysis protocols. These will consist of new sections and/or subsections placed into the

appropriate plan. Minor word changes or typographical corrections will not be considered updates and will not require SAP revision number changes.

SAP updates will be tracked on the SAP Update and Revision Page (Appendix A). Updates requiring revision changes will be distributed to all concerned parties requiring knowledge of the updated SAP. Updates requiring no revision changes will be distributed only to those individuals directly affected by the update.

FIELD SAMPLING PLAN
ACCRA PAC/WARNER BAKER SITE
ELKHART, INDIANA
CONSENT DECREE
CIVIL ACTION NO. H89-0113

OCTOBER 20, 1993

PREPARED FOR
ACCRA PAC, INC.

PREPARED BY
EIS ENVIRONMENTAL ENGINEERS, INC.
1701 NORTH IRONWOOD DRIVE
SOUTH BEND, INDIANA

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FIGURES

TABLES

TABLE

1.0 EIS 1990 REPORT OF INVESTIGATION

An evaluation of soil and groundwater contamination at the Warner P. Baker/Accra Pac site was performed by EIS Environmental Engineers, Inc. (EIS) in 1990. This report documented extent of contamination studies.

The report was submitted in September 1990 and was titled "Report of the Investigation of Contamination at the Warner P. Baker/Accra Pac Site, Elkhart, Indiana". This report is included by reference in this FSP and will be termed the "EIS 1990 Report" whenever it is referenced in this FSP.

2.0 SAMPLING OBJECTIVES

The specific objective of any sampling conducted at the Warner Baker site will be driven by the specific end use of the data. The specific end use of the data will dictate both the qualitative and quantitative requirements for the sample collection program.

Qualitative and Quantitative requirements will be established for each specific end use by a consideration of the following Data Quality Requirements.

Activity	Response/Possible Scenarios
Objective	Sampling of soil, groundwater and air to determine project specific end use.
Data End Use	• Site Characterization • Risk Assessment • Specific Product Identification • Engineering Design • Remediation Effectiveness • Adherence to Cleanup Criteria
Contaminants	• Volatile Organic Compounds • Multicomponent Residuals (TPH) • Semi-Volatile Organic Compounds • Heavy Metals • Physical Properties • Nutrients

Activity	Response/Possible Scenarios
Level of Concern	• ppm • ppb
Critical Samples	• Non random designated sites • Clean samples after remediation • Clean samples after soil excavation
Number of Samples	• To achieve objective
Background Samples	• May or may not be required
QA/QC Samples	• Required due to end use • Not required due to end use
Sampling Procedures	• Drill rig with split-spoon sampler • Hand auger • Bailers • Hydropunch
Sample Types	• Soil, Water, Air • Grab, Composite

2.1 *MCR Investigation - Compound Identities*

The specific objective of this sampling effort will be to collect and identify the soil contaminants termed MCR. The EIS 1990 Report indicated that this product consisted of numerous organic constituents of the type generally associated with a Petroleum Product or Fuel.

The collection and subsequent laboratory analysis will be geared to a qualitative analysis program only. No specifically defined Levels of Detection or of Quality Control analysis steps such as Matrix Spiking to determine recovery are applicable to this sampling strategy.

The end products from the sampling, laboratory analysis and subsequent data interpretations will be the following:

- Identities of the individual components comprising the MCR as provided by a computerized Mass Spectrometry "Library Search" employing a mass spectral library of over 60,000 compounds.

- A determination of the presence/absence of chlorinated Volatile Organic Compounds.

- A determination as to the applicability of disposal of MCR contaminated soil by excavation and land disposal.

3.0 SAMPLE LOCATION AND FREQUENCY

Individual field investigations which require sample collection will determine locations and number of samples to collect. These determinations will thus be investigation specific, designed to achieve the stated Sampling Objective(s).

3.1 MCR Investigation - Compound Identities

Two (2) specific areas have been designated as MCR "hot spots". These two areas will comprise the location of the sample collection activities.

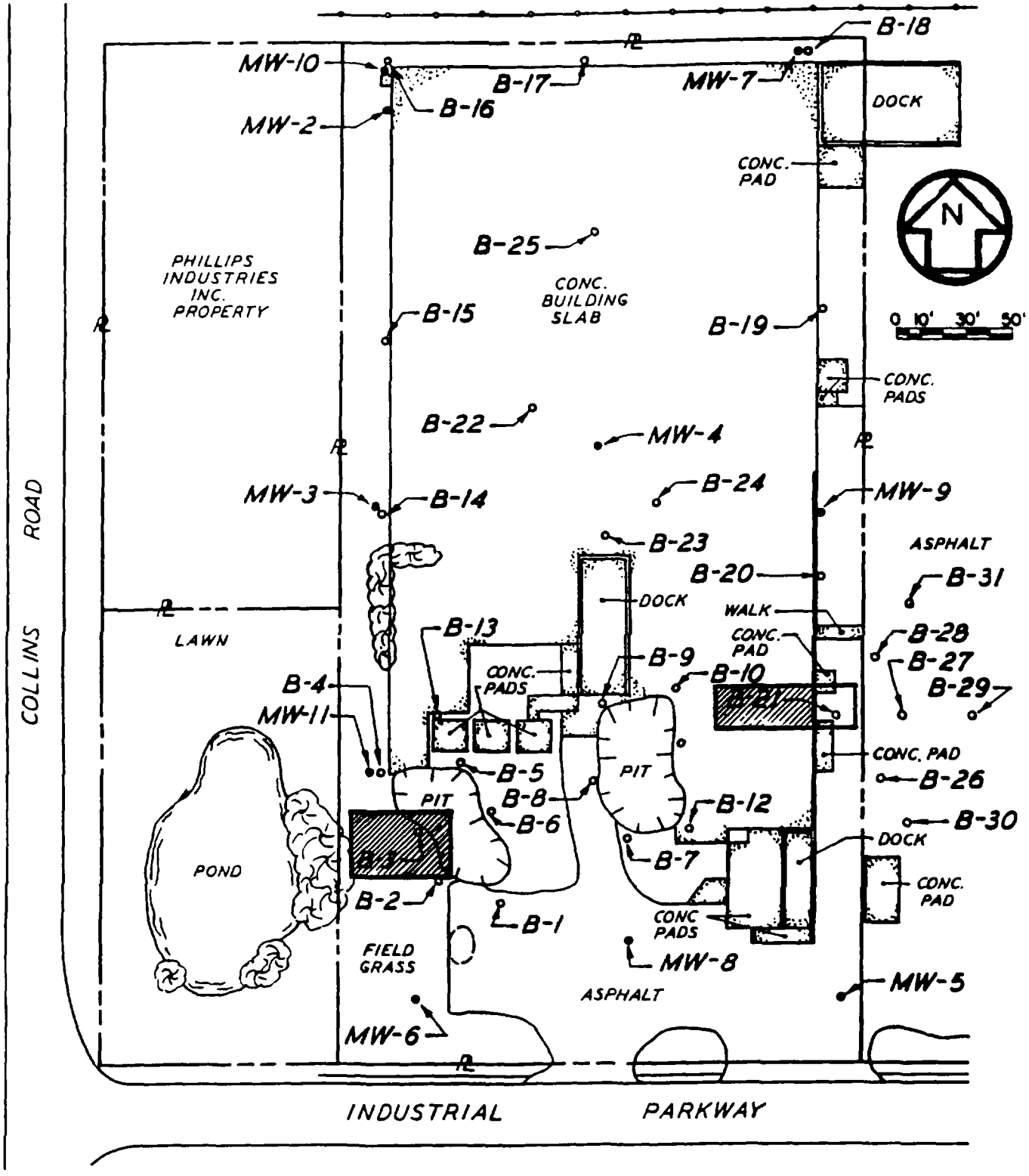
One (1) boring will be conducted in the center of each individual "hot spot". The approximate locations of these two borings are indicated in Figure 3.1.

Three (3) individual split-spoon samples will be collected from each boring. These samples will be representative of a vertical profile roughly identified as follows:

- Sample #1 - Near the uppermost elevation of the hot spot.
- Sample #2 - Near the center of the hot spot.
- Sample #3 - Near the bottommost elevation of the hot spot.

Based on the EIS 1990 Report, the following sampling points have been selected:

Sample #	B-3	B-21
1	5.5'	7.0'
2	7.5'	9.0'
3	9.5'	11.0'



EXPLANATION

PROPOSED SAMPLING LOCATIONS FOR MCRS.

FIGURE 3.1

PROPOSED SAMPLING LOCATIONS FOR MCR INVESTIGATION

FIG-3-1

4.0 SAMPLE DESIGNATIONS AND RECORDKEEPING

Due to the potentially large number of samples which may need to be collected to support field studies, a standardized system for nomenclature and numbering will be employed. This system will be used regardless of the sampling objective and will be designed to allow a logical interpretation of sample types collected during any sampling event.

This standardized nomenclature system will require both a Primary Description and a Secondary Description for each sample. These two description fields are necessary to allow proper log in of samples in the EIS laboratory via a Laboratory Information Management System (LIMS).

Field record keeping requires that sample identifications be provided on at least the following three documents:

- Sample Container Label (Figure 4.1)
- Laboratory Analysis Request Sheet (Figure 4.2)
- Chain-of-Custody Record (Figure 4.3)

For any sampling event (1 day in the field), the following guidelines are to be followed:

- The number of container labels which need to be completed will depend on the number of containers.

- One Laboratory Analysis Request Sheet and one Chain-of-Custody form will suffice for all samples of the same matrix requiring the same analysis.

FIGURE 4.1

SAMPLE CONTAINER LABEL

EIS ENVIRONMENTAL ENGINEERS, INC.

1701 North Ironwood Drive • South Bend, Indiana 46635

CLIENT _____

SAMPLE NO. _____

DESIGNATION _____

ANALYSIS _____

PRESERVATIVE _____

DATE _____ BY _____

FIGURE 4.2

EIS LABORATORY ANALYSIS REQUEST FORM
(One form per sample is MANDATORY)

EIS Client/Project: _____ Project Manager: _____	EIS Laboratory No.: _____ Date Sample Received: _____

CLIENT INFORMATION	SAMPLE INFORMATION
Client Name: _____ Client Address: _____ _____ Client Tel #: _____ Contact Person: _____ Client P.O. #: _____	___ Wastewater ___ Tap Water ___ Mon Well H_2O ___ Ground H_2O ___ Surface H_2O ___ Leachate ___ Sludge/Sediment ___ Soil/Sand ___ Solid ___ Oil ___ OSHA Type Sample ___ Asbestos

Report To:	Sampling Site _____ Location _____
Extra Report To:	Primary Sample Description _____ Secondary Sample Description
Invoice To:	Composite ___ Grab ___ Both ___ Date Collected _____ Time Collected _____ Collected by _____

* * * * * * * * * * * * * * * * * * **GENERAL CHEMISTRIES** * * * * * * * * * * * * * * * * * *

Parameter	X	Parameter	X	Parameter	X
Acidity, Total		Nitrogen Compounds		Specific Conductance	
Alkalinity, Bicarb		. Ammonia (Direct)		Sulfate	
Alkalinity, Total		. Ammonia (Man Dist)		Sulfide, Tot Acid Sol	
BOD_5, Carbonaceous		. Nitrate		Surfactants, CTAS	
BOD_5, Soluble		. Nitrate + Nitrite		Surfactants, MBAS	
BOD_5, Total		. Nitrite		TOC	
Chloride		. Organic		TOH	
Chlorine, Residual		. TKN			
COD		Oil & Grease (Freon)		**Additional Tests**	
Coliform, E. Coli		Oil & Grease (Soxhlet)			
Coliform, Fecal (MF)		Oil & Grease (5520F)		Asbestos, Bulk	
Coliform, Total (MPN)		pH		Asbestos, Fiber	
Coliform, Plate Count		Phenols (Direct)		Gross Alpha	
Coliform, Total + Fecal		Phenols (Man Dist)		Gross Beta	
Cyanide, Amenable		Phosphorus, Ortho		Radium 228	
Cyanide, Free		Phosphorus, Total		Radon	
Cyanide, Tot (Direct)		Silica		Tritium	
Cyanide, Tot (Man Dist)		Solids, Tot		Turbidity	
Fluoride (Direct)		Solids, Tot Dissolved		Color	
Fluoride (Man Dist)		Solids, Tot Suspended			
Hardness		Solids, Vol Suspended			
Moisture		Solids, Vol Total			

EIS USE ONLY	Sample Plan Name	Sample Receipt Information

HEAVY METALS
See Legend at Bottom

Detection Limit DW ___
Detection Limit WW ___
Total Metal Required ___
Soluble Metal Required ___

Metal	X	EIS Use
Aluminum	___	
Antimony	___	
Arsenic	___	
Barium	___	
Beryllium	___	
Bismuth	___	
Boron	___	
Cadmium	___	
Calcium	___	
Chromium, T	___	
Chromium,Hex	___	Color
Cobalt	___	
Copper	___	
Iron	___	
Lead	___	
Magnesium	___	
Manganese	___	
Mercury	___	Cold Vap
Molybdenum	___	
Nickel	___	
Potassium	___	Flame
Selenium	___	
Silicon	___	
Silver	___	
Sodium	___	
Thallium	___	
Tin	___	
Titanium	___	
Vanadium	___	
Zinc	___	

LEGEND
- DW =Drinking Water Limits
- WW =All other type Limits
- Soluble metals need to be filtered. Has this sample been filtered.
  Yes ___ No ___

ORGANICS

. Is this sample for TPH?
  Yes ___ No ___
. If Yes, the following MUST BE ANSWERED
1. Is this a Tank Closure?
  Yes ___ No ___
2. Suspected TPH is
  _____

BETX ___
Herbicides, Acids ___
Herbicides, Unknowns ___
PCB ___
Pesticides, Chlorinated ___
Pesticides, Unknown ___
SVOC, Acid Fraction ___
SVOC, B/N ___
SVOC, BNA ___
TPH ___
VOC, Hall/PID ___
VOC, GC/MS ___

List, by Name, any special compounds of importance to your analysis
- - - - - - - - - - - - - - - -

HAZARDOUS WASTE CLASSIFICATION TESTS

For TCLP samples, is Matrix Spike Required:
Yes _____ No _____

Corrosivity ___
Ignitability ___
Reactivity (CN & S) ___
Paint Filter ___
Neutral Leaching ___
TCLP Metals ___
TCLP Volatiles ___
TCLP Semi-Volatiles ___
TCLP Herbicides ___
TCLP Pesticides ___

If Neutral Leaching or TCLP Metals are required, check the specific tests you need.

Parameter	TCLP	Neutral Leach
Arsenic	___	
Barium	___	
Cadmium	___	
Chromium	___	
Lead	___	
Mercury	___	
Selenium	___	
Silver	___	
Copper	___	
Iron	___	
Manganese	___	
Nickel	___	
Sodium	___	
Zinc	___	
Chloride	___	
TDS	___	
pH (24 hrs)	___	
Fluoride	___	
Phenols	___	
Sulfate	___	
Cyanide, Tot	___	
Sulfide, Tot	___	
TOC	___	
TOH	___	

SPECIAL INSTRUCTIONS TO THE LABORATORY

EIS USE ONLY
Client No. _____
Project No. _____
Task No. _____
Dept. No. _____

FIGURE 4.3

CHAIN OF CUSTODY RECORD

CLIENT NO.	PROJECT NO.	PROJECT NAME
SAMPLERS: (SIGNATURE)		

DATE AND TIME OF COMPOSITE	DATE AND TIME OF GRAB	PRIMARY SAMPLE DESCRIPTION	NO. OF CONTAINERS	TYPE OF CONTAINERS	REMARKS	EIS LAB NO.	SAMPLE STATE	TEMP COOLER BLANK

SEE REVERSE SIDE FOR INSTRUCTIONS

EIS LAB USE ONLY

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

SAMPLE STATE
C = COLD
N = NOT COLD
I = INTACT
B = BROKEN

MODE OF TRANSPORTATION	
EIS VEHICLE #	PUBLIC

FIELD NOTES:

-FSP10-

EIS ENVIRONMENTAL ENGINEERS, INC. 1701 N. IRONWOOD DR. SOUTH BEND, IN 46635 (219) 277-5715

INSTRUCTIONS

1. Along the slanted lines, write in the Type of Container from the list of allowable entries given below. Indicate Total Number of Containers in the column provided.

2. In the squares along each sample description row, under the specified Type of Container, enter a letter code shown below to indicate that 1) Tests from this Type of Container are required for this sample and 2) these tests are from a Grab or Composite.

   Letter Codes: G = Grab C = Composite

3. The List of Allowable Entries for Type of Container is as follows. Associated designations are: (FS) = French Square; (LM) = Large Mouth; (A) = Amber

Type of Container - Water	Tests Which Can Be Performed From This Container
40 cc vial	VOC, TPH, BETX
Unpres, Plastic	Acidity, Alkalinity, BOD, Chloride, Fluoride, Hardness, Ortho Phosphorus, Silica, Solids (all kinds), Sp Cond, Sulfate, Surfactants, NITRATE FROM CHLORINATED WATER SOURCES ONLY, Nitrite, Cr^{+6}, pH
HNO_3, Plastic	Metals
H_2SO_4, Glass (FS)	Oil & Grease
H_2SO_4, Plastic	Ammonia, COD, Nitrate + Nitrite, Nitrate (non-Chlorinated Water), Total Phosphorus, TKN
H_2SO_4, Glass	TOH, TOC
H_2SO_4, Glass (A)	Phenol
NaOH, Plastic	Cyanide
NaOH+Zn, Plastic	Sulfide
Thiosulfate, Glass (A)	SVOC
Unpres, Glass (A)	Pesticides/PCB
Unpres, Glass (A)	Herbicides
Type of Container - Soil	
40 cc vials	VOC, TPH and BETX
Unpres, Glass (LM)	All types of tests

4. Individual tests to be performed are to be specified on the EIS Laboratory Analysis Request Form.

Matrix changes and/or analysis changes will require a different Laboratory Analysis Request Sheet/Chain-of-Custody combination.

Completion of each of the field documents is to then be done according to the table below.

	Required On		
Sample Description in	Label	Lab Request Sheet	Chain-of-Custody
Primary Description Field	Yes	No	Yes
Secondary Description Field	No	No	Yes

The Chain-of-Custody form is the only one requiring both Primary and Secondary sample description fields. Primary and secondary description fields will be separated by brackets. An example is [HA-BH#1(0-1')][Hot Spot Sample].

Standardized Nomenclature System

Required Primary Sample Descriptions are presented in Table 4.1. Secondary Descriptions can be used by Project Managers/samplers to further identify each sample or event in any manner chosen.

Restrictions on field lengths are as follows:

- Primary Field 30 Characters
- Secondary Field 80 Characters

TABLE 4.1
STANDARDIZED NOMENCLATURE FOR PRIMARY SAMPLE DESCRIPTION

Primary Description	Matrix	Type	Definition
SS-BH #1 (0-3')	Soil	Environmental	Split Spoon, Borehole #1 @ 0-3' Depth
SS-BG #1 (0-3')	Soil	Background	Split Spoon, Background #1 @ 0-3' Depth
HA-BH #1 (0-1')	Soil	Environmental	Hand Auger, Borehole #1 @ 0-1' Depth
HA-BG #1 (0-1')	Soil	Background	Hand Auger, Background #1 @ 0-1' Depth
MW#1	Water	Environmental	Monitoring Well #1
HP-BH #1 (12-15')	Water	Environmental	Hydropunch, Borehole #1 @ 12-15' Depth
AA#1	Air	Environmental	Ambient Air Sample #1
SV#2	Air	Environmental	Soil Vapor Sample #2
SS-FB #1	Water	Field Blank	Split Spoon Equipment Rinse Blank #1
HA-FB #2	Water	Field Blank	Hand Auger Equipment Rinse Blank #2
MW-FB #5	Water	Field Blank	Monitoring Well Equipment Rinse Blank #5
TB (10-16-93)	Water	Trip Blank	Trip Blank with Preparation Date Shown

Notes:

1. Field Duplicates are designated simply as FD #1 or FD #2. Since these are recorded on a Chain-of-Custody form specific to one matrix, it is not necessary to use any other descriptors.

2. The Field Duplicate is related to the specific environmental sample, for which it is a duplicate of, on the field data sheets. These sheets are not evident to laboratory personnel and the field duplicate is thus a "blind" sample.

3. Samples selected for Quality Control of Matrix Spike/Duplicate Matrix Spike are identified by the descriptor (MS/DMS) placed immediately after the Primary Description.

4.1 MCR Investigation - Compound Identities

Sample designations and recordkeeping will be per Section 4.0.

5.0 SAMPLING EQUIPMENT/PROCEDURES

The specific sampling equipment as well as the procedures associated with its use will be dictated by the intent of a field sampling event. It is anticipated that soil, groundwater and/or air sampling may be required during the life of this project.

Sampling equipment reasonably expected to be required by the scope of this project and general procedures for its use is described below.

Soil Sampling

The obtainment of soil samples will be by one of two procedures:

- Drill Rig with Standard Split Spoon Sampler
- Hand Auger

Individual split spoon samples will initially be screened with a Field PID analyzer to determine the total volatile organic load prior to sample containerization. This screening will also evaluate the ambient air quality in the vicinity of the sampler with respect to the requirements of the Health and Safety Plan (HSP).

Hand augered boreholes will also be screened with the PID to evaluate ambient air quality with respect to the HSP.

Samples will be containerized immediately after the PID screening in containers specific to the end use of the samples. Headspace will be eliminated to as great an extent as possible, with specific attention given to samples for VOC analysis. Sample seals will be placed around the lids and the containerized samples will immediately be placed on ice, in a cooler, awaiting transportation to the laboratory.

Split spoons, hand augers and other sample collection tools will be decontaminated between sampling points. Spent decontamination fluid will be collected for disposal offsite, in accordance with existing regulations.

Decontamination procedures will consist of the following:

- Brush off loose dirt
- Wash with TSP solution
- Rinse three (3) times with deionized water

Each cooler used to store containerized VOC sample vials, as well as other sample types, will be accompanied by a Sample Cooler Log, documenting internal temperatures.

Field data sheets will be employed to record sampling information.

Figure 5.1 to 5.3 present copies of the cooler log and field data sheets.

Water Sampling

The obtainment of water samples will be by use of the following procedures:

- Bailers
- Hydropunch
- Manual collection directly into a container

Sampling objectives will define which equipment and procedures will be employed.

FIGURE 5.1
SAMPLE COOLER LOG

Client Name: _____

Project Number: _____

Cooler Number	Temperature Check(s) (date/time/temp)

Sampler(s): _____
Signature(s)

Guidelines:
1. For sampling events where samples are in the cooler for less than 4 hours, nc temperature check is required.
2. For sampling events where temperature checks are judged necessary, based on EIS's SOI for Field Cooling of environmental samples, the frequency of those checks shall be determined by the sampler(s), based on their judgement and the goal of maintainin ice cover in the cooler.
3. Cooler number should be recorded on the Chain-of-Custody form, using a blan container type column or the "REMARKS" section.

1150 Revised (04-14-93)

FIGURE 5.2

MONITORING WELL SAMPLING FORM

Well I.D. : _____ Client: _____

Sample I.D. _____ Project No.: _____

Sample Date: / / ___ : ___ **am pm** Location: _____

EIS Lab No.: _____ Laboratory: _____

Well Sampling Sequence: _____ Sample Collectors: _____

PRE-PURGE

Elevation Top of Casing **(TOC):** _____ Well Material: ***PVC STAINLESS GALVANIZED TEFLON***

SWL Depth from TOC **(Ft):** _____ Inside Diameter **(D):** _____

Well Depth from TOC **(Ft):** _____ SWL Elevation **(Ft):** _____

TOC to grade **(Ft):** _____ Grade Elevation **(Ft):** _____

Immiscible layers: ***PRESENT ABSENT*** Well Depth From Grade **(Ft):** _____

Immiscible Layer Detection Method: _____

SWL Measurement Method: _____

SAMPLE CONTAINERS & PRESERVATIVE

Analytic Parameters: **See EIS Laboratory Request Form**

Metals Filtered Prior to Preservation: ***YES NO METALS NOT ANALYZED***

Filtration Method: ***GRAVITY VACUUM PRESSURE***

Filter Type: ***CARTRIDGE PAPER*** Pore Size: _____

Internal Temperature of Field & Shipping Containers: **See EIS Cooler Log Form**

Containers:

Size	Type	Quantity	Preservative	Laboratory	Transportation

FIELD OBSERVATIONS

PURGE

Time & Date Purged: / / ___ : ___ am pm

Purge Volume: **(Gal):** _____

Total Volume Purged **(Gal):** _____

Well Volumes Purged: ***DRY / 1 2 3 4 5 6 7 8 9 10***

Purging to Stabilization: ***REQUIRED*** ***NOT REQUIRED***

No. Of Gallons	Temp	pH	Specific Cond.

Stabilization Limits

Temp. +/- 0.5 ° C

pH +/- 0.1

Sp. Cond. +/- 10

Purge Method: **PUMP:** Type: _____

Make: _____

Rate: _____

BAILER: ***PVC TEFLON***

Rope Material: ***POLY*** _____

Equipment Dedicated: ***YES NO***

Equipment Decontaminated With:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

pH Meter Type: _____ Sp. Cond Meter Type: _____

SAMPLING

Sample Date: / / ___ : ___ **am pm**

Weather Conditions:

Temperature: _____ Sky: _____

Wind: _____ Ground: _____

SWL Depth from TOC (Prior To Sampling) **(Ft):** _____

Height of Water Column Prior To Sampling **(Ft):** _____

Recovery to Original Depth **(%):** _____

Water Appearance:

CLEAR SLIGHTLY VERY Turbid

Color:

CLEAR GRAY BROWN BLACK _____

Indicator Parameters (Field)

pH	Specific Cond.

Sample Method: **PUMP:** Type: _____

Make: _____

Rate: _____

BAILER: ***PVC TEFLON***

Rope Material: ***POLY*** _____

Equipment Dedicated: ***YES NO***

Equipment Decontaminated With:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

pH Meter Type: _____ Sp. Cond Meter Type: _____

Signature: _____ **Date:** _____

FIGURE 5.3

Sheet ___ Of ___

Project No. _____

SOIL SAMPLE LOG

Client: _____ Site Location _____ Date _____

Equipment Used _____ No. of Samples Collected _____ Container Size _____

Sample No.	Sample Location	Time	Depth	Type of Material	EIS Lab No.	Analysis Requested

Comment: _____

_____

Collectors Name _____

5.1 MCR Investigation - Compound Identities

The sample collection activities for this task will be performed by use of a drill rig and split spoon sampler. The procedures described in Section 5.0 Soil Sampling will be followed.

6.0 SAMPLE HANDLING/ANALYSIS REQUIREMENTS

This section of the FSP will define many default protocols which must be followed in order to ensure that the overall sampling program results in valid, representative and legally defensible samples after they have been extracted from the environmental source.

Specific sampling events may involve items other than those discussed below. These types of items will be documented at the time that they become known. The following key areas are discussed herein:

- Sample Containers/Preservatives/Analytical Holding Times
- Sample Collection Order
- Analysis Specification
- Chain-of-Custody Procedures
- Sample Transportation

Sample Containers/Preservatives/Analysis Holding Times

Table 6.1 summarizes these requirements.

TABLE 6.1

CONTAINERS, PRESERVATION TECHNIQUES, HOLDING TIMES

Analyte/Test Group	Container(1)	Size	Preservative(2)	Holding Time
INORGANICS				
Acidity	P,G	1L	Cool	14 days
Alkalinity	P,G	1L	Cool	14 days
BOD	P,G	1L	Cool	48 hrs
Chloride	P,G	1L	Cool	28 days
Chlorine Residual	P,G	1L	Analyze Immediately	
COD	P,G	1L	Cool,H_2SO_4,pH<2	28 days
Cyanide	P,G	1L	Cool,NaOH,pH>12	14 days
Fluoride	P	1L	Cool	28 days
Hardness	P,G	1l	Cool,HNO_3pH<2	6 months
Nitrogen,Ammonia	P,G	1L	Cool,H_2SO_4,pH<2	28 days
Nitrogen,Nitrate (chlorinated source)	P,G	1L	Cool	28 days
Nitrogen,Nitrate(nonchlorinated)	P,G	1L	Cool,H_2O_4,pH<2	14 days
Nitrogen,Nitrite+Nitrate	P,G	1L	Cool,H_2SO_4,pH<2	28 days
Nitrogen,Nitrite	P,G	1L	Cool	48 hrs
Nitrogen,Organic & Kjeldahl	P,G	1L	Coo,H_2SO_4,pH<2	28 days
Oil & Grease	G	1L	Cool,H_2SO_4,pH<2	28 days
pH	P,G	1L	Cool	Analyze Immediately
Phenols	G	1L	Cool,H_2SO_4,pH<2	28 days
Phosphorus, Ortho	P,G	1L	Cool	48 hrs
Phosphorus, Total	P,G	1L	Cool,H_2SO_4,pH<2	28 days
Silica	P	1L	Cool	28 days
Solids (all kinds)	P,G	1L	Cool	7 days
Specific Conductance	P,G	1L	Cool	28 days
Sulfate	P,G	1L	Cool	28 days
Sulfide	P,G	1L	Cool,Acetate & NaOH	7 days
Surfactants, MBAS & CTAS	P,G	1L	Cool	48 hrs

Analyte/Test Group	Container(1)	Size	Preservative(2)	Holding Time
TOC	G(T)	1L	Cool,H_2SO_4,pH<2	28 days
TOH	G(T)	1L	Cool,H_2SO_4,pH<2	8 days
Turbidity	P	1L	Cool	48 hrs
METALS				
Total Metals,General	P(A)	1L	Cool,HNO_3,pH<2	6 months
Soluble Metals,General	P(A)	1L	Filter then HNO_3,pH<2	6 months
Chromium +6	P(A)	1L	Cool	24 hrs
Mercury	P(A)	1l	Cool, HNO_3,pH<2	28 days
ORGANICS				
VOC	G(T)	40cc	Cool,HCl	14 days
Pesticides	G(T)	1L	Cool	7 days extraction 40 days instrument
Herbicides	FG(T)	1L	Cool	7 days extraction 40 days instrument
SVOC	G(T)	1L	Cool	7 days extraction 40 days instrument

EXPLANATIONS

(1) Container types are defined as follows:

P=Plastic (polyethylene)

G=Glass

(T)=Teflon Septa lid liner

(A)=Acid rinsed

(2) Preservatives are defined as follows:

- Cool means 4°C or ice temperature
- Soil samples require no preservatives

Sample Collection Order

Soil samples have no special filling order.

Water samples are collected according to the following sample container filling order.

- Volatile Organics
- Semi-Volatile Organics
- Total Metals
- Dissolved metals
- Phenols
- Cyanide
- Inorganics (unpreserved)
- Nitrate/Ammonia

Analysis Specification

This is sampling event specific and will be addressed for each event as it becomes known.

Chain-of-Custody Procedures

This process is intended to maintain a known level of control over collected samples. This control is evidenced by use of Chain-of-Custody documents. The EIS Chain-of-Custody form is shown in Figure 4.3.

Each individual who releases custody of samples in his possession must sign the Released By block and place the time/date of release in the appropriate block. The individual accepting custody of these samples must also sign.

It is acceptable to release samples to the EIS laboratory walk-in cooler in the event that sample delivery is made after normal working hours.

Transportation

All samples will be transported to the EIS laboratory by EIS vehicles. The vehicle driver may or may not be the field sampler.

6.1 MCR Investigation - Compound Identities

Analysis specifications, along with additional sample collection requirements, are given below.

- Required Analysis - VOC, SVOC
- Trip Blank Required - No
- Field Blank Required - No
- Field Duplicates Required - No
- MS/DMS Required - No
- Sample Containers - 3 VOC vials per sample
- Preservative Required - No
- Analysis Turn-around Time - Normal

QUALITY ASSURANCE PROJECT PLAN
ACCRA PAC/WARNER BAKER SITE
ELKHART, INDIANA
CONSENT DECREE
CIVIL ACTION NO. H89-0113

OCTOBER 20, 1993

PREPARED FOR
ACCRA PAC, INC.

PREPARED BY
EIS ENVIRONMENTAL ENGINEERS, INC.
1701 NORTH IRONWOOD DRIVE
SOUTH BEND, INDIANA

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1.0 PROJECT DESCRIPTION

1.1 Introduction

This Quality Assurance Project Plan (QAPP) has been prepared in accordance with the provisions of the Consent Decree No. H89-0113 lodged with the United States District Court of Northern Indiana, South Bend Division. This plan is an integral part of the overall Sampling and Analysis Plan (SAP).

1.2 Quality Assurance Project Plan (QAPP) Objective

The objective of this QAPP is to describe in detail Quality Assurance/Quality Control (QA/QC) procedures to be employed during various field and laboratory activities in support of Predesign and Final Design tasks in the remediation/removal of contaminated soil and groundwater at the Warner Baker site.

Procedures described in this QAPP are those reasonably expected to occur during the course of this investigation. It is possible that this plan may need to be updated as various remedial technologies are evaluated in support of the Consent Decree Statement of Work (SOW).

This QAPP is a companion document to the Field Sampling Plan (FSP). Both documents form the overall Sampling and Analysis Plan (SAP).

1.3 Site Background

The site background is described in the Introduction section of the Sampling and Analysis Plan (SAP).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Overall Structure

The overall structure of the EIS project team is presented in Figure 2.1. Responsibilities of project team members are as follows.

EIS Project Coordinator

An EIS principal is in overall charge of this project. Responsibilities of the principal include communication with the client, regulatory agencies, input into project work plan formulation, and final review of conclusions and recommendations for Reports of Findings.

Project Manager

The Project Manager's responsibilities include review of all project data, scheduling of activities, correspondence and direct reporting to the EIS Principal in charge. This individual will also function as the Alternate Project Coordinator.

Engineering Manager

This individual is directly responsible for oversight of all engineering design work which will be developed during the course of this project.

PROJECT ORGANIZATION
ACCRA PAC/WARNER BAKER SITE
REMEDIAL DESIGN PHASE

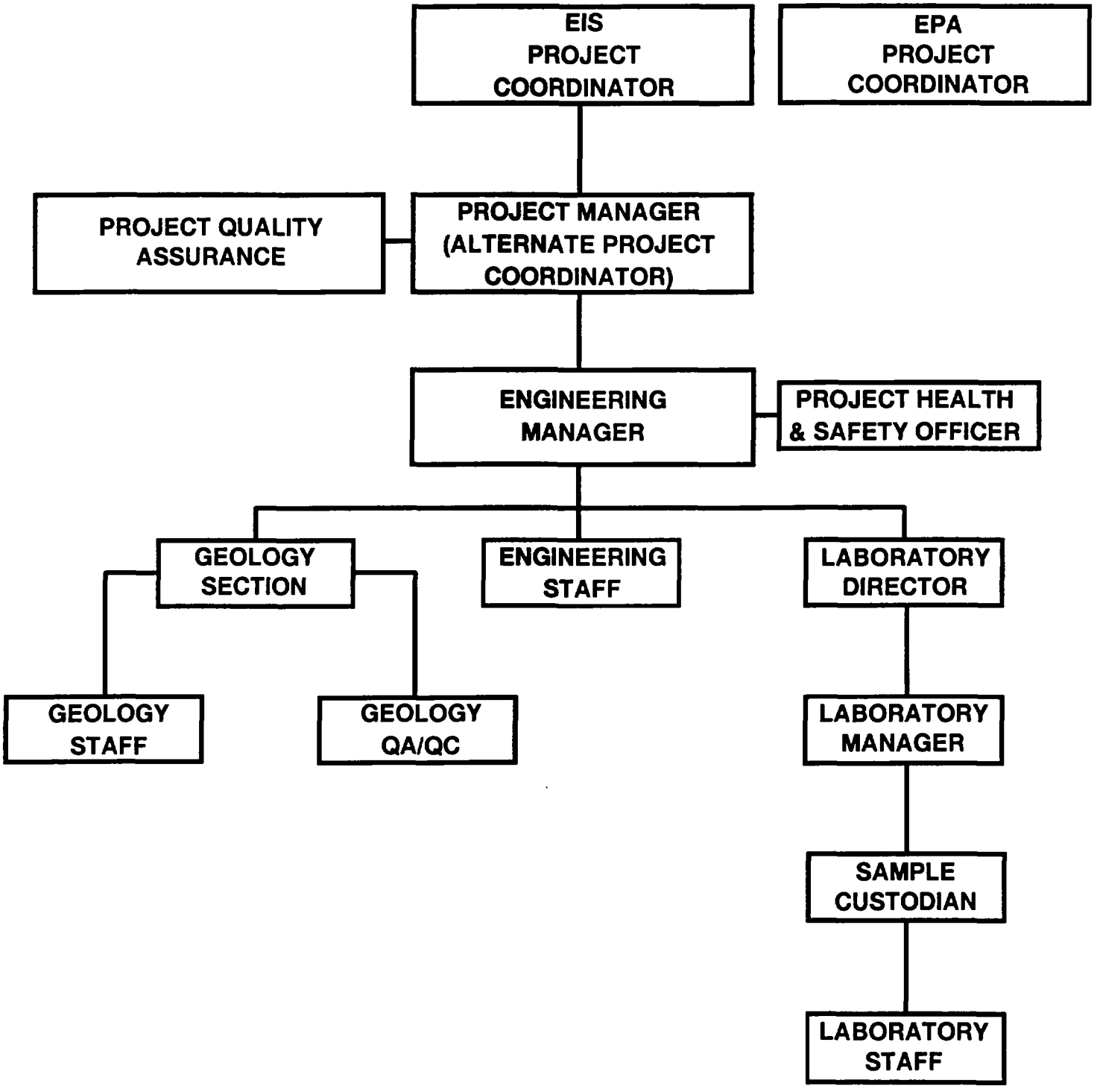


Figure 2.1

Health and Safety Director

This individual is in overall charge of all health and safety considerations applicable to this project. The Health and Safety Officer coordinates his/her activities with the Engineering Manager. The decisions of the Health and Safety Officer are final with respect to controlling worker-adherence to the Health and Safety Plan.

Laboratory Director

This individual is in charge of all EIS QA/QC activities and is responsible for formulating project specific QA/QC plans, reviewing all field and laboratory information generated and accepting or rejecting the generated data.

Project Geologists/Engineers

The geologists/engineers responsibilities include collecting soil samples, performing borings, conducting field measurements, maintaining equipment cleanliness, performing proper decontamination procedures and carrying out the work according to the Project Work Plan.

Laboratory Manager

The Laboratory Manager's responsibilities include overall management of laboratory activities, adherence to laboratory QA/QC procedures, scheduling of laboratory resources and reporting directly to the Laboratory Director.

Sample Custodian

The sample custodian is responsible for inspection and log-in of incoming samples, acceptance of the samples via Chain-of-Custody and control of sample storage.

2.2 Staff Assignments

The following EIS staff have been assigned the responsibilities indicated below:

Project Coordinator:	H. Stephen Nye, P.E.
Project Manager:	John R. Wingard, P.E.
Engineering Manager:	Daniel W. Akin, P.E.-L.S.
Health & Safety Director:	Anne C. Rozite, E.H.S.
Laboratory Director:	Andris Rozite
Laboratory Manager:	David M. Nye
Sample Custodians:	Penny Povlock/Colleen Wright
Project Engineers:	Staff
Project Geologists:	Staff

Sampling and analysis for this project will be completed by:

EIS Environmental Engineers, Inc. (EIS)
1701 North Ironwood Drive
South Bend, IN 46635

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 Purpose of the Plan

The success in meeting the objective of the field investigation is greatly dependent on the quality of data generated during the project. To ensure the highest quality data possible, a project specific Quality Assurance/Quality Control Plan is implemented. This plan, commonly called a Quality Assurance Project Plan (QAPP), includes operational guidelines for the following two major project areas:

- Field Sampling Activities
- Laboratory Analysis Activities

The primary objective of this QAPP is to guarantee that all data generated in the investigation are of sufficient quality to allow a well informed evaluation of the analytical data.

Data quality is limited by the following parameters which this plan will address:

- Completeness - the adequacy in quantity of valid measurements both to ensure accurate interpretation and to answer all important questions.

- Representativeness - the extent to which discrete measurements accurately describe the greater picture which they are intended to represent. Good representativeness is achieved through careful, informed selection of analytical parameters.

- Accuracy and Precision - the agreement between a measurement and the true value and the degree of variability of the measurement. Accuracy and precision of data depend upon the measurement standards used and the meticulous, competent use of them by qualified personnel.

Reasonable confidence in project developed data is dependent upon many factors which influence overall performance. The following are three key areas affecting the overall project.

3.2 QAPP Distribution

The QAPP is distributed by the Laboratory Director to the Project Manager, Laboratory Manager and Health and Safety Officer.

The Plan is then further distributed by each manager to project personnel performing key tasks in a manager's sphere of responsibility.

3.3 Training

All EIS personnel and those of its subcontractors will be properly trained, qualified individuals. Prior to commencement of work, personnel will be given instructions specific to a certain project or investigation.

- Line of authority and communication
- Overview of the project scope
- Documentation requirements
- Safety and health requirements
- Decontamination procedures

3.4 Document Control

Both field sampling and laboratory analysis phases of any project result in accumulation of documents such as boring logs, laboratory bench sheets, Chain-of-Custody forms and one-time documents such as Work Plans.

Document control is a formal system of activities that ensure that:

- All participants in the project are informed of all specific documents which need to be maintained.

- All participants in the project are promptly informed of any revisions to the sampling and analysis and/or the QAPP.

- All critical documents generated during the analysis are accounted for during and at the end of the project.

The documents accumulated during the project will be reviewed by the Project Manager and Laboratory Director for correctness and completeness. Copies of these documents will be included in Reports of Findings for which this QAPP is being submitted. The original documents will be archived at EIS.

4.0 SAMPLING PROCEDURES

4.1 Mobilization

Appropriate sampling equipment, sample containers and field documents will be assembled prior to departure for the site.

4.2 Sample Containers

Container requirements will be based on the analytical requirements developed for each field sampling program designed to support various remedial design and/or soil excavation protocols. Individual task specific container requirements will be documented in Section 6.0 of the Field Sampling Plan (FSP).

Containers will be requested by field staff using the EIS Bottle Request Form, Figure 4.1.

4.3 Sampling Methods

Field sampling equipment and methods are addressed in the Field Sampling Plan and are incorporated herein by reference.

4.4 Sample Handling

The Geologist/Engineer collecting the samples will don new, powderless, disposable gloves before collecting each sample. All samples are to be custody sealed and placed into appropriate containers at ice temperature. Figure 4.2 shows the custody seal which will be used.

BOTTLE REQUEST FORM

INSTRUCTIONS

This form is to be accompanied by a fully completed Laboratory Analysis Request sheet, stapled to this form. The Laboratory Analysis Request Sheet describes the matrix and the tests to be performed. A Chain-of-Custody sheet will be provided by the laboratory which lists the bottle types required by this Bottle Request Form.

Changes in matrix or tests will require that a different Laboratory Analysis Request sheet be provided, along with another Bottle Request Form. A separate Chain-of-Custody will then also be in place. (This will usually be the case for Trip Blanks.)

Labels may be filled out by the laboratory if time permits. This needs to be discussed between project staff and laboratory staff. Special instructions are placed on back of this form.

REQUESTER SECTION

Client Name:_____
Project No.:_____
Requester Name:_____
Date Submitted:_____
Date Bottles Needed:_____
Number of Samples:_____
Number of Field Duplicates (FD):_____
Total Number (Samples + FD):_____

Describe QC (Spike) Requirements

LABORATORY SECTION

Bottles Prepared by:_____ Date Completed:_____

General Test Category	Container Type	Preservative	Number Per Sample/FD	Total Number Samples/FD	Total No. Container Types

TOTAL CONTAINERS PER SAMPLE/FD [____]

QC (Spike) Requirement Bottles

CUSTODY SEAL

Person Collecting Sample _____ Sample No. _____
(signature)

Date Collected _____ Time Collected _____

4.5 *Sampling Equipment Decontamination*

All non-disposable sampling equipment that comes in direct contact with soil or water samples (split-spoons, scoopulas, hand auger heads, bailers, etc.) will be decontaminated between samples by washing in a non-phosphate detergent solution and rinsing three (3) times with potable water.

The wash and rinse water generated during this decontamination will be collected and containerized for disposal offsite in accordance with existing regulations. All decontaminated sampling equipment is to be protected from accidental contamination on the site. New plastic bags or aluminum foil may be used for this purpose.

4.6 *Quality Control Samples*

Field Equipment Blanks, consisting of EIS deionized water exposed to soil or water sampling equipment, will be collected on the basis of one Field Blank for each 20 samples or as specified by task specific requirements. The Field Equipment Blank will be taken after sampling equipment decontamination and will be collected for analytical parameters identified in the Field Sampling Plan.

Field Duplicate samples will be collected on the basis of one per 10 soil samples and one per 10 water samples or as specified in the Field Sampling Plan. The Field Duplicate will be identified with nomenclature similar to an environmental sample. The fact that it is a duplicate will not be evident to the laboratory. Field Duplicate samples will be collected for analytical parameters identified in the Field Sampling Plan.

Field Duplicate samples will be used for matrix spike and duplicate matrix spike analysis per Section 6.2. These samples must therefore be collected in sufficient volume to allow

this analysis to be performed. They must also be identified as samples which require matrix spike and duplicate matrix spike analysis by adding the letters **"MS/DMS"** to the sample field identifications. For example, a Field Duplicate sample assigned the field ID **"FD1"**, which is to be analyzed for organics, would be labeled as **"FD1(MS/DMS)"**.

Trip Blanks, are required for water samples but have no meaning for soil samples. These blanks, consisting of laboratory water in appropriate containers, will be prepared in the laboratory at the beginning of each sampling day when water sampling is scheduled. These trip blanks will accompany the Project Engineer/Geologist into the field and will be transported and stored with the samples collected that day. Trip blanks will be prepared only for VOC analysis unless specifically required to support other project goals.

4.7 Field Documentation

Field documentation will be maintained by the Project Engineer/Geologist. This documentation is over and above sample custody requirements discussed in Section 5.2. Field documentation requirements for this project include the following forms and documents:

- Soil Sample Log (Figure 4.3)
- Monitoring Well (Figure 4.4)
- Project Engineer's/Geologist's Field Notebook.

Unusual events requiring departure from the Field Sampling Plan will be documented.

Sheet ___ Of ___

Project No. _____

SOIL SAMPLE LOG

Client: _____ Site Location _____ Date _____

Equipment Used _____ No. of Samples Collected _____ Container Size _____

Sample No.	Sample Location	Time	Depth	Type of Material	EIS Lab No.	Analysis Requested

Comment: _____

_____

Collectors Name _____

MONITORING WELL SAMPLING FORM

Well I.D. : _____ Client: _____

Sample I.D. _____ Project No.: _____

Sample Date: / / __ : __ am pm Location: _____

EIS Lab No.: _____ Laboratory: _____

Well Sampling Sequence: _____ Sample Collectors: _____

PRE-PURGE

Elevation Top of Casing **(TOC):** _____ Well Material: ***PVC STAINLESS GALVANIZED TEFLON***

SWL Depth from TOC **(Ft):** _____ Inside Diameter **(D):** _____

Well Depth from TOC **(Ft):** _____ SWL Elevation **(Ft):** _____

TOC to grade **(Ft):** _____ Grade Elevation **(Ft):** _____

Immiscible layers: ***PRESENT ABSENT*** Well Depth From Grade **(Ft):** _____

Immiscible Layer Detection Method: _____

SWL Measurement Method: _____

SAMPLE CONTAINERS & PRESERVATIVE

Analytic Parameters: **See EIS Laboratory Request Form**

Metals Filtered Prior to Preservation: ***YES NO METALS NOT ANALYZED***

Filtration Method: ***GRAVITY VACUUM PRESSURE***

Filter Type: ***CARTRIDGE PAPER*** Pore Size: _____

Internal Temperature of Field & Shipping Containers: **See EIS Cooler Log Form**

Containers:

Size	Type	Quantity	Preservative	Laboratory	Transportation

FIELD OBSERVATIONS

PURGE

Time & Date Purged: / / ___ : ___ am pm

Purge Volume: **(Gal):** _____

Total Volume Purged **(Gal):** _____

Well Volumes Purged: ***DRY / 1 2 3 4 5 6 7 8 9 10***

Purging to Stabilization: ***REQUIRED*** ***NOT REQUIRED***

No. Of Gallons	Temp	pH	Specific Cond.

Stabilization Limits

Temp. +/- 0.5 ° C

pH +/- 0.1

Sp. Cond. +/- 10

Purge Method: **PUMP:** Type: _____

Make: _____

Rate: _____

BAILER: ***PVC TEFLON***

Rope Material: ***POLY*** _____

Equipment Dedicated: ***YES NO***

Equipment Decontaminated With:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

pH Meter Type: _____ Sp. Cond Meter Type: _____

SAMPLING

Sample Date: / / ___ : ___ am pm

Weather Conditions:

Temperature: _____ Sky: _____

Wind: _____ Ground: _____

SWL Depth from TOC (Prior To Sampling) **(Ft):** _____

Height of Water Column Prior To Sampling **(Ft):** _____

Recovery to Original Depth **(%):** _____

Water Appearance:

CLEAR SLIGHTLY VERY Turbid

Color:

CLEAR GRAY BROWN BLACK _____

Indicator Parameters (Field)

pH	Specific Cond.

Sample Method: **PUMP:** Type: _____

Make: _____

Rate: _____

BAILER: ***PVC TEFLON***

Rope Material: ***POLY*** _____

Equipment Dedicated: ***YES NO***

Equipment Decontaminated With:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

pH Meter Type: _____ Sp. Cond Meter Type: _____

Signature: _____ **Date:** _____

5.0 SAMPLE CUSTODY

5.1 Purpose and Definition

Custodial procedures to ensure the integrity of collected samples begin in the field and terminate upon completion of satisfactory analysis. An analysis is deemed satisfactory after data reduction and validation.

To maintain and document sample possession, Chain-of-Custody procedures are followed. A sample is under custody if:

- It is in your possession, or
- It is in your view, after being in your possession, or
- It was in your possession and then you locked it up to prevent tampering, or
- It is in a designated secure area.

5.2 Field Custody Procedures

5.2.1 Documentation

Prior to commencement of sampling, the Project Manager will instruct the sampling team in the Sample Custody procedures to be used.

This project will require the following documentation to support sample custody:

- Chain-of-Custody Forms (see Figure 4.3 of the FSP)

- Sample Bottle Labels (see Figure 4.1 of the FSP)
- Laboratory Analysis Request Forms (see Figure 4.2 of the FSP)

5.2.2 Project Engineer/Geologist Responsibilities

The Project Engineer/Geologist is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly. This same individual is personally responsible for completion of the required documentation during the sampling phase with the exception of Laboratory Analysis Request Forms, which are to be completed by the Project Manager or EIS Principal.

5.2.3 Sample Storage

Samples will be stored in coolers containing ice under the observation of the Project Engineer/Geologist. Coolers, when filled, will be placed in an EIS vehicle. The vehicle will be locked if the Project Engineer/Geologist must leave the site vicinity.

The Project Manager, or his designee, will ensure that required custody documentation is properly maintained and that the samples are physically in possession of the Project Engineer/Geologist.

5.3 Laboratory Custody Procedures

5.3.1 Sample Transportation

For this project, collected samples will be delivered to the EIS laboratory via EIS field vehicles.

5.3.2 Release of Custody

The collected samples will be released to the laboratory by the Project Engineer/Geologist via the Chain-of-Custody form. The EIS Laboratory Sample Custodian will, at this time, perform the following functions:

- Verify completeness of sample labels and Chain-of-Custody forms.
- Verify sample integrity (custody seal intact)
- Determine whether samples were properly refrigerated during transportation.
- Sign and date the Chain-of-Custody.
- Log the samples into the laboratory via the Laboratory Information Management System (LIMS).
- Place samples into the walk-in cooler for storage until analysis time.

5.3.3 Laboratory Custody

The Laboratory Manager will be responsible for assigning laboratory work load and ensuring that samples are returned to the walk-in cooler at the end of the analysis day.

5.3.4 Sample Disposal

No samples will be disposed of until analyses are completed, the data reviewed and subsequently accepted. Disposal of samples will be in keeping with applicable regulations.

6.0 ANALYTICAL PROCEDURES

6.1 Methods

Table 6.1 summarizes extraction methods, analytical methods and detection limits for some reasonably expected organic analysis requirements for this remedial investigation.

This table will be updated, if required during the course of this project, to reflect additional analysis information.

The EIS laboratory performs environmental analysis according to approved methods published by organizations such as USEPA. References which could be required for use during this remedial investigation are:

1. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" SW-846 and all updates.

2. Federal Register 40 CFR, Parts 141 and 142, June 29, 1989.

3. "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

6.2 EIS Laboratory SOP

The analysis schemes utilized will follow EIS laboratory SOPs. The SOP have been designed to incorporate analysis steps which allow a review of data by the Laboratory Director with respect to its quality. Key features from two SOPs have been extracted and summarized in Tables 6.3 and 6.4.

TABLE 6.1

ANALYTICAL METHODS

Parameter/ Matrix	Method of[1] Extraction	Method of[1] Analysis	Detection Limit
VOC/soil	Methanol & 5030	8260[3]	[2]
VOC/water	5030	8260[3]	[2]
SVOC/Soil		8270[3]	
SVOC/Water		8270[3]	

(1) Reference: "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 3rd Edition

(2) See Table 6.2 for specific target compounds and EQLs.

(3) Both method 8260 and 8270 will reveal the presence of Petroleum Products such as gasoline, fuel oils or waste oils.

TABLE 6.2
TARGET LIST VOLATILE ORGANIC COMPOUNDS (VOC)
AND ESTIMATED QUANTITATION LIMITS (EQL)

Compound Name	EQL Water (µg/l)	EQL Soil (ppm)	Compound Name	EQL Water (µg/l)	EQL Soil (ppm)
Acetone	10	0.5	2,2-Dichloropropane	5	0.25
Acrolein	20	1.0	1,1-Dichloropropene	2	0.10
Acrylonitrile	20	1.0	c-1,3-Dichloropropene	2	0.10
Benzene	1	0.05	t-1,3-Dichloropropene	2	0.10
Bromobenzene	1	0.05	Diethyl Ether	10	0.50
Bromochloromethane	1	0.05	Ethylbenzene	1	0.05
Bromoethane	1	0.05	Ethyl Methacrylate	5	0.25
Bromodichloromethane	1	0.05	n-Heptane	5	0.25
Bromoform	2	0.10	Hexachlorobutadiene	2	0.10
Bromomethane	2	0.10	2-Hexanone	10	0.50
n-Butyl Benzene	2	0.10	Iodomethane	1	0.05
sec-Butyl Benzene	2	0.10	Isopropyl Benzene	2	0.10
tert-Butyl Benzene	2	0.10	p-Isopropyltoluene	2	0.10
Carbon Disulfide	2	0.10	Methylene Chloride	2	0.10
Carbon Tetrachloride	2	0.10	Methyl Ethyl Ketone	10	0.50
Chlorobenzene	1	0.05	Methyl Isobutyl Ketone	10	0.50
Chlorodibromomethane	1	0.05	Methyl Methacrylate	5	0.25
Chloroethane	2	0.10	Naphthalene	2	0.10
2-Chloroethylvinyl Ether	10	0.50	Nitrobenzene	50	2.5
Chloroform	1	0.05	Paraldehyde	1000	50
1-Chlorohexane	2	0.10	n-Propyl Benzene	1	0.05
Chloromethane	10	0.50	Styrene	1	0.05
2-Chlorotoluene	1	0.05	tert-Butyl Methyl Ether	2	0.10
4-Chlorotoluene	1	0.05	1,1,1,2-Tetrachloroethane	2	0.10
Cyclohexanone	100	5.0	1,1,2,2-Tetrachloroethane	1	0.05
1,2-Dibromo-3-chloropropane	30	1.5	Tetrachloroethene	1	0.05
1,2-Dibromoethane	1	0.05	Tetrahydrofuran	10	0.50
c-1,2-Dibromoethylene	2	0.10	Toluene	1	0.05
t-1,2-Dibromoethylene	2	0.10	1,2,3-Trichlorobenzene	1	0.05
Dibromomethane	2	0.10	1,2,4-Trichlorobenzene	1	0.05
1,2-Dichlorobenzene	2	0.10	1,1,1-Trichloroethane	1	0.05
1,3-Dichlorobenzene	2	0.10	1,1,2-Trichloroethane	1	0.05
1,4-Dichlorobenzene	2	0.10	Trichloroethene	1	0.05
1,4-Dichloro-2-butene	30	1.5	Trichlorofluoromethane	2	0.10
Dichlorodifluoromethane	2	0.10	1,2,3-Trichloropropane	5	0.25
1,1-Dichloroethane	1	0.05	1,1,2-TCTFE*	2	0.10
1,2-Dichloroethane	1	0.05	1,2,4-Trimethylbenzene	2	0.10
1,1-Dichloroethene	2	0.10	1,3,5-Trimethylbenzene	2	0.10
c-1,2-Dichloroethene	1	0.05	Vinyl Acetate	10	0.50
t-1,2-Dichloroethene	1	0.05	Vinyl Chloride	2	0.10
Dichlorofluoromethane	2	0.10	m + p-Xylenes	2	0.05
1,2-Dichloropropane	1	0.05	o-Xylene	1	0.05
1,3-Dichloropropane	2	0.10	Petroleum Hydrocarbons(PH)	500	20

TABLE 6.3

OPERATION AND FREQUENCY

ORGANIC ANALYSIS

Operation	Frequency
• Method Blank Analysis	Daily or more often
• Calibration Check Standard Analysis	Daily or more often
• Replicate Sample Analysis	1/10 or as required
• Field Blank/Trip Blank Analysis	As Required
• Duplicate Matrix Spike Analysis	1/10 or as required
• Field Duplicate Analysis	1/20 or as required
• Tuning Compound Analysis (GC/MS Only)	Daily
• Response Factor Analysis (GC/MS Only)	Daily
• Surrogate Compound Analysis (GC and GC/MS)	Each Sample
• Laboratory Controls	Daily or as required

TABLE 6.4
QUALITY CONTROL STEPS/CONTROL LIMITS/INTERPRETATION

Quality Control Step	Analysis	Control Limits/Interpretation
Method Blanks	VOC	No response above EQL except common lab solvents of methylene chloride, acetone and freon which are not to exceed 5X EQL.
Daily Calibration Standards	VOC	SPCC/CCC Criteria
Tuning Compound	VOC	BFB Criteria
Surrogate Recovery	VOC	Compound Dependent
Field Duplicate Analysis	VOC	<35% Relative Difference except near EQL.
Matrix Spike Duplicate Spike	VOC	Compound Dependent

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 Calibration Schedule

The following schedule is employed for the laboratory Equipment known to be required by this project.

Parameter	Scheduled Calibrations
VOC	Daily at start of sequence
SVOC	Daily at start of sequence

7.2 Calibration Procedures

Procedures employed are per SW-846 Method 8260 for VOC and Method 8270 for SVOC.

8.0 DATA REDUCTION, VALIDATION, REPORTING

8.1 Data Reduction

The EIS laboratory SOP requires each analyst to reduce the data directly attributable to his/her work. In many situations, initial data reduction is performed automatically, by dedicated instrument computer systems.

8.2 Data Validation

Initial data validation is performed by the individual analysts using the following guidelines:

- Computer printouts contain all samples, standards, controls placed into the sequence.

- Initial results do not exceed (by more than 20%) the high end calibration curve standard.

  If detector saturation has occurred, the analyst is required to immediately reanalyze that sample using appropriate dilutions.

- Calibration check standards must be within acceptable limits.

  This check for VOC and SVOC is performed prior to the start of a batch run.

- Tuning criteria for GC/MS must be met.

This check is performed prior to the start of a batch run. BFB and DFTPP criteria is employed for VOC and SVOC respectively.

- Surrogate recoveries for individual samples for organic analysis must be within QA limits.

  If a sample falls outside of these limits, it is reanalyzed. If still outside the limits, a matrix problem is assumed.

- Method Blanks (representative of the entire analysis procedure including digestions, filtrations) and Calibration Blanks must not show analyte of interest interferences above QC limits.

  If contaminated blanks (sought after analyte interferences) are present, and exceed acceptable QC interpretations, the source of the problem is traced prior to continuation.

8.3 Reporting

Initial data is reported by the individual analysts to the Laboratory Manager and subsequently to the Laboratory Director.

The reporting package includes all validation data for review by the managers.

9.0 INTERNAL QUALITY CONTROL CHECKS

The majority of internal QC checks are performed by the individual analysts using the criteria specified in Sections 7.0 and 8.0 of this QAPP.

Internal QC checks not under the direct interpretation of the individual analyst are Initial Laboratory Controls submitted by the Laboratory Director. These controls, obtained from USEPA-EMSL Cincinnati are submitted at various times as "unknowns". Thereafter, they become Laboratory Control Samples, routinely analyzed, with known results. These results must be within acceptable QC criteria and are part of the initial data validation.

On-line evaluation of all internal QC checks is a must for laboratories operating in an atmosphere where samples have limited "holding times".

10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 Performance Audits

Audits to evaluate quantitative laboratory results are normally scheduled on the basis of twice per year. These audits consist of participation in USEPA Region V water supply and water pollution studies.

Unscheduled performance audits occur when EIS clients receive, from USEPA, audit samples representative of their analysis requirements. These clients then request that EIS perform the analysis.

10.2 System Audits

These types of audits are performed at various times of the year. These audits in general consist of evaluating methods and procedures used with those specified in either the laboratory SOP or a QA/QC Plan.

A system audit will be performed by the Laboratory Director for this project. This audit will consist of, but not be limited to, the following elements as they pertain to this project:

- Sample handling procedures including sample integrity
- Records control documenting laboratory procedures
- Document control including Chain-of-Custody

11.0 PREVENTIVE MAINTENANCE

11.1 Laboratory Equipment

The objective of the preventative maintenance program is to decrease equipment downtimes, ensuring to as great an extent as possible, the ability to meet analytical holding times.

Preventative maintenance for laboratory test equipment varies considerably. The majority of preventative maintenance is taken from manufacturer's recommended schedules.

Operational history of laboratory equipment also dictates certain preventative maintenance requirements.

For this project, routine preventative maintenance schedules apply to the following types of equipment:

- GC/MS
- Auto Sampler
- Purge & Trap Unit
- Data System

Routine preventative maintenance is performed on varying basis for the equipment specified. Instrumental and/or operational characteristics dictate the maintenance requirement. The Analytical Balance is scheduled for servicing by its manufacturer once per year.

11.2 Field Sampling Equipment

No special preventative maintenance is applicable to sample containers, hand augers and other hand tools except for visual inspections.

The EIS subcontractor owning the mobile drill rig maintains his own equipment.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

12.1 Precision

This data quality check is assessed by comparing either Field Duplicate or Laboratory Replicate Relative Percent Difference values.

This check is performed initially by the analyst developing the data. Subsequent review is performed by the Laboratory Manager and ultimately the Laboratory Director.

12.2 Accuracy

This data quality check is assessed by determining Percent Recovery (% R) of a known analyte from a specified matrix. Recovery can be ascertained in one of two ways:

- Recovery of analyte from a reference sample such as USEPA Water Pollution or Water Quality studies
- Recovery of a Matrix Spike

Matrix spike recoveries (organic and inorganic) are monitored by the individual analysts at the time that a test is being performed. Inorganic matrix spikes are single spike analysis. Organic Matrix Spikes are performed in Duplicate. Organic matrix spikes, in addition to providing Percent Recovery data, also allow a determination of Precision, expressed as Relative Percent Difference.

Percent Recovery and Relative Percent Difference values generated at the time of analysis are immediately compared to the Quality Control limits established for that test.

12.3 Completeness

This data quality check is made by the following evaluation.

- Were all analysis performed within specified holding times?
- Were all samples scheduled for analysis actually analyzed?

Completeness is expressed as a percentage and is calculated by:

$$\text{Percent Complete} = \frac{\text{Number of Samples Analyzed} \times 100}{\text{Number of Samples Submitted}}$$

13.0 CORRECTIVE ACTION DURING ANALYSIS

The need or necessity for corrective actions is based on the initial data validation by the individual analysts and subsequently by reviews performed by the Laboratory Manager and Laboratory Director.

Holding time requirements for the majority of tests conducted at EIS dictate that maximum flexibility be given to the person performing the test. Corrective actions dictated by the Laboratory Director are in general not applicable to sample reanalysis. These are geared toward changes in procedure or methodology.

Corrective actions during analysis are dictated by exceeding previously established Quality Control Limits, interpretation of instrumental behavior or any condition which, in the judgment of the analyst, may require scrutiny.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Laboratory Director at EIS is in a management position. The Director reviews all data released from EIS.

APPENDIX A

SAP UPDATE AND REVISION TRACKING SHEET

SAP UPDATE AND REVISION TRACKING SHEET
ACCRA PAC/WARNER BAKER SITE - CONSENT DECREE

Old Revision Number/Date	New Revision Number/Date	Items Causing Revision	Revised By
0.0 (10-20-93)			

APPENDIX B

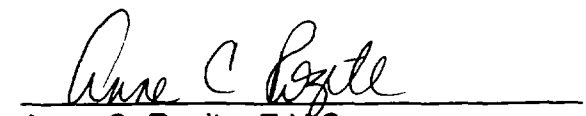
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
FOR FIELD DESIGN ACTIVITIES
ACCRA PAC/WARNER BAKER SITE
INDUSTRIAL PARKWAY
ELKHART, INDIANA

OCTOBER 20, 1993

PREPARED FOR
ACCRA PAC, INC.
ESTATE OF WARNER BAKER

PREPARED BY
EIS ENVIRONMENTAL ENGINEERS, INC.
1701 NORTH IRONWOOD DRIVE
SOUTH BEND, INDIANA



Anne C. Rozite, E.H.S.
Health and Safety Specialist

CONTENTS

1.0 INTRODUCTION

1.1 GENERAL

This Health and Safety Plan (HSP) has been designed for the conduct of work at the Accra Pac Industrial Parkway Site in Elkhart, Indiana. The procedures established by this plan are intended to protect on-site personnel, visitors and the public from physical harm and exposure to contaminated soil and groundwater. The guidelines and procedures specified in this plan are based on the best available information at the time of the plan's preparation. The plan will be reviewed and updated as necessary to reflect changes in site conditions or exposure hazards. Revisions to the plan will be included in Appendix A.

This plan applies to activities which involve potential health hazards or exposure to hazardous substances.

1.2 Site Activities

Field Design Activities at the site may include the following:

- Soil borings.
- Subsurface soil and groundwater sampling.
- Monitoring well installation.

1.3 Compliance with HSP

Operations conducted during this project which pose a potential health hazard or potential for exposure to hazardous substances will conform to the applicable

requirements of the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations Standard (29 CFR 1910.120). Operations covered by this HSP must be conducted in compliance with any other applicable federal, state and local health and safety regulations.

Persons who are unwilling or unable to comply with the required standards and with this HSP will not be permitted on the site.

2.0 PROGRAM ORGANIZATION AND ADMINISTRATION

2.1 GENERAL

The HSP will be implemented through the joint efforts of the Engineering Manager (EM), the Health and Safety Officer (HSO) the designated Site Safety Officer (SSO), EIS field staff and subcontractors.

2.2 Program Responsibilities

The EIS **Health and Safety Officer** (HSO) will:

- Develop, review and update the HSP as necessary.
- Ensure compliance with the HSP through site visits and review of field documents and reports.

The **Engineering Manager** (EM) will:

- Coordinate health and safety requirements with the SSO.
- Ensure that the conduct of work at the site is in accordance with requirements of this plan.

The **Site Safety Officer** (SSO) will:

- Ensure that all personnel are familiar with hazards on site and with safety procedures required to minimize exposure to these hazards.

- Perform on-site surveillance to ensure compliance with established health and safety requirements.

- Perform air quality monitoring and observe environmental conditions.

- Maintain logs related to health and safety surveillance.

- Collect training and medical documentation from personnel covered by this plan.

- Provide first aid when necessary.

- Coordinate emergency procedures and site evacuation if necessary.

All personnel involved in this project will be required to be familiar with the contents of this Site Safety Plan and to:

- Comply with procedures of the health and safety plan.

- Report safety problems or concerns to the Engineering Manager or Site Safety Officer.

3.0 HAZARD ASSESSMENT

3.1 Chemical Hazards

An investigation of the site conducted in 1989 by EIS identified various volatile organic compounds as soil and groundwater contaminants. The specific contaminants, along with health effects and exposure data are listed below. An **S** in the Comments column indicates soil contaminant and **GW** indicates groundwater contamination.

Contaminant	ppm PEL/TLV /STEL[1]	IDLH[2]	Primary Routes of Exposure	Symptoms	Comments
1,1-Dichloroethane (1,1 DCA)	100/200/250	4,000	Inhalation Ingestion Skin/Eye Contact	Depression of central nervous system; skin irritation; liver kidney damage	Chloroform-like odor **GW**
1,2-Dichloroethane	1/10/2	1,000 CA[3]	Inhalation Ingestion Absorption *Skin/Eye Contact*	Depression of central nervous system; nausea, vomiting; dermatitis, *eye irritation*	Chloroform-like odor **GW**
1,1-Dichloroethene	-/5/20	NA[4]	Inhalation	NA	**S, GW**
Cis-1,2 Dichloro-ethene	200/200/-	4,000	Inhalation Ingestion Skin/Eye Contact	Eye irritant; respiratory system irritant; central nervous system depressant	Acrid Chloroform-like odor **GW**
Tetrachloroethene	25/50/200	500 CA	Inhalation Ingestion Skin/Eye Contact	Eye, nose, throat irritant; nausea; vertigo; headache	Mild,Chloroform like odor **S, GW**
1,1,1-Trichloro-ethane (1,1,1 TCA) (Methyl Chloroform)	350/350/450	1,000	Inhalation Ingestion Skin/Eye Contact	Headache, lassitude; depression of central nervous system; poor equilibrium; eye irritation dermatitis, cardiac arrythmia	Mild, Chloro-form-like odor **S, GW**
Trichloroethylene (TCE)	50/50/200	1,000 CA	Inhalation Ingestion Skin/Eye Contact	Headache; vertigo; visual disturbance; somnolence; nausea; vomiting; eye irritation; dermatitis; cardiac arrythmia	Chloroform-like odor **S, GW**
Vinyl Chloride	1/5/5	CA	Inhalation	Weakness; abdominal pain; GI bleeding	**GW**

Chemical Hazards (continued)

Dichlorofluoro-methane	-/10/-	NA	NA	NA	**GW**
Trichlorofluoro-methane	-/1,000/-	NA	NA	NA	**GW**
1,1,2-Trichloro-trifluoroethane	1,000/-/1,250	NA	Inhalation Ingestion Skin/Eye Contact	Throat irritation; drowsiness; dermatitis	**S, GW**
1,2-Dichlorobenzene	50/50/-	1,000	Inhalation Skin absorption Ingestion Skin/Eye Contact	Nose, eye irritation; liver, kidney damage; skin blisters	**S, GW**
Ethyl Benzene	100/100/125	2,000	Inhalation Ingestion Skin/Eye Contact	Eye, mucous, membrane irri-tation; headache; dermatitis; narcosis	Aromatic Odor **S, GW**
Toluene	100/100/150	2,000	Inhalation Skin absorption Ingestion	Fatigue; weakness; confusion euphoria; dizziness; headache dilated pupils	Sweet, pungent benzene-like odor **S, GW**
Xylene	100/100/150	1,000	Inhalation Skin absorption Ingestion Skin/Eye Contact	Dizziness, excitement; drowsiness; incoherence; eye, nose, throat irritation; nausea; vomiting; abdominal pain	Aromatic Odor **S, GW**

Notes:

(1) PEL = Permissible Exposure Limit (Occupational Safety and Health Administration)
TLV = Threshold Limit Value (American Conference of Governmental Industrial Hygienists)
STEL = Short Term Exposure Limit (OSHA AND ACGIH)

(2) IDLH = Immediately Dangerous to Life and Health

(3) CA = Carcinogen

(4) NA = Not Available

The potential for exposure to some or all of these chemicals will exist during the performance of various tasks which may be required during this project. This potential will vary with the specific task and will be greater for some Primary Routes of Exposure than for others.

Overexposure to these chemicals will be highly unlikely when this HSP is implemented and followed.

Potential for exposure is ranked below based on specific tasks and Primary Routes of Exposure. The terms High and Low simply indicate where exposure potential is either Highest or Lowest.

	Exposure Potential		
Task/Activity	Vapor Inhalation	Soil Ingestion	Soil or Water Skin/Eye Contact
Drill Rig Operator	Low	Low	High (Soil)
Split Spoon Opening	High	Low	High (Soil)
Manual Soil Sampling	High	Low	High (Soil)
Monitoring Well Inst.	Low	Low	Low
Groundwater Sampling	Low	Low	High (Water)
Equipment Decontamin.	Low	Low	High (Soil)
General Ambient Air	Low	Low	Low

3.2 Physical Hazards

- Underground Utilities - The appropriate utility will be contacted to determine presence of buried cables or gas lines at the site.

- Cold Stress - When the temperature falls below 40°F, cold stress protocol will be followed. American Conference of Governmental Industrial Hygienists (ACGIH) recommended guidelines will be followed for Cold Stress Prevention. These guidelines are included in Appendix C.

- Heat Stress - When the temperature exceeds 70°F and personnel are wearing protective clothing, a heat stress monitoring program will be implemented as

appropriate. This program will follow the recommended guidelines of the American Conference of Governmental Industrial Hygienists (ACGIH). These guidelines are included in Appendix D.

- Fire/Explosion - Based on prior knowledge of the site the potential for fire and explosion is very low. Fire extinguisher will be kept at the site and smoking or open flames will be prohibited in the work areas.

- Slips, trips, falls - Personnel will be alerted to the danger posed by uneven terrain at the site and other site conditions which pose the potential for slips, trips and falls.

4.0 TRAINING

All personnel performing activities covered by this HSP and who enter the exclusion or decontamination zones must have received training in accordance with 29 CFR 1910.120 (e) including the initial 40 hours and annual refresher training and supervisor training as appropriate. Subcontractors at the site who are covered by this HSP must provide written documentation of training to the EIS Health and Safety Officer prior to the start of the project.

Site specific training will be provided to all personnel covered by this HSP at a safety meeting to be held prior to the start of the project. Subjects to be covered include the following:

- Names of personnel and alternates responsible for site safety and health.
- Potential effects of chemical hazards at the site, including symptoms of overexposure.
- Requirements for and use of personal protective equipment.
- Action Limits and Responses.
- Work practices to minimize risks from hazards.
- Personal hygiene practices.
- Decontamination procedures.
- Emergency procedures and communication
- Confined space entry procedures.
- Spill containment procedures.

Personnel entering the site will sign the Site Safety Plan Acknowledgment form (Appendix B) to indicate they are familiar with the above subjects and will comply with the requirements of the HSP.

5.0 PERSONAL PROTECTIVE EQUIPMENT

5.1 Respiratory Protection

Previous activities at this site involving the same tasks covered by this HSP indicate that exposure to persistent vapor levels exceeding the action limits defined in Section 7.0 is unlikely. In the event that vapor levels persist above the action limits, half mask air purifying respirators equipped with organic vapor cartridges will be used. The level of respiratory protection may be downgraded as vapor levels drop below the action limits.

Personnel required to use respirators must be trained in the use of the type of respirator which they will use, and have passed a respirator fit test for the specific respirator to be used within the past six months.

5.2 Protective Clothing

During well drilling, soil boring drilling, soil sampling and decontamination of equipment, significant skin contact with contaminated soil is likely. Protective clothing required during these activities will be a modified Level C as follows:

- Disposable Tyvek coverall
- Work Boots
- Outer rubber or vinyl boots
- Inner disposable vinyl gloves
- Outer work gloves
- Safety glasses or shield
- Hard hat
- Half mask Air Purifying Respirator as necessary.

Groundwater sampling activities are expected to result in minimal skin contact. Level D protective clothing will provide adequate protection during this task.

- Regular work uniform
- Disposable vinyl gloves
- Safety glasses
- Work Boots

Hard hats and safety glasses will be worn in the vicinity of the drill rig regardless of the task being performed.

A portable eyewash station will be maintained in any area where equipment decontamination is taking place.

5.3 Levels of Protection

Levels of protection anticipated for this site are defined below.

Level C Protection Shall Be Used When:

- The same level of skin protection as Level B, but a lower level of respiratory protection is required,
- Air contaminants have been identified and an air-purifying respirator will provide adequate protection, or,
- The substance has adequate warning properties.

Level C Protective Equipment at a Minimum Shall Consist of:

- Coveralls
- Work boots
- Chemical resistant boots or disposable boot covers
- Disposable inner gloves
- Disposable outer gloves
- Full or half-face Air Purifying Respirator
- Chemical cartridge or canister
- Hard-hat; and,
- Ankles and wrists taped with duct tape.

Level D Protection Shall Be Used When:

- The atmosphere contains no known hazard, and,
- Work functions preclude splashes, immersion or the potential for unexpected inhalation of, or contact with, hazardous concentrations of harmful chemicals.

Level D Protection Equipment at a Minimum Shall Consist of:

- Standard work uniform or coveralls
- Work boots
- Gloves, as needed
- Splash shield as needed
- Hard-hat
- Safety glasses

6.0 MEDICAL SURVEILLANCE

Personnel performing operations covered by this HSP and who are exposed to levels of airborne contaminants above the PELS or published limits will participate in a medical monitoring program in accordance with 29 CFR 1910.120 (f).

7.0 AIR MONITORING

7.1 Equipment

An HNU PI 101 Photoionization Detector (PID) with an 11.7 ev lamp will be used to determine breathing zone vapor levels.

7.2 Action Limits and Response Actions

Activities which are likely to generate the highest vapor levels of hazardous substances include operations during which soil will be disturbed. These activities are:

- Drilling of monitoring wells and boreholes
- Subsurface soil sampling

Vinyl Chloride and 1,2 dichloroethane (Ethylene dichloride) have the lowest OSHA PELS of the contaminants identified at the site; however these compounds are found only in groundwater. Since groundwater sampling activities are not expected to be a major source of vapor levels, the Action Limits for this site will be based on the presence of 1,1 Dichloroethylene, which has the lowest PEL of the soil contaminants identified.

Worker exposure protection must consider the fact that this compound could be present by itself and therefore be responsible for the total reading observed by the PID.

Significant sensitivity differences (to the PID) exist for the various VOC expected to be present. Although the PID will be calibrated per EIS Standard Operating Procedure (SOP), the Action Limit concentration will be based on the response of a

Trichloroethylene standard to the calibration curve. The Action Limits defined below will be readings above background.

Trichloroethylene has been chosen since its photoionization potential is closer to that of 1,1-Dichloroethylene than would be the calibration gas compound (Isobutylene).

ACTION LIMITS/RESPONSE ACTIONS
EXPRESSED AS TRICHLOROETHYLENE

Action limit for PID Reading	Persistence of Reading in Breathing Zone	Response Actions
<5 ppm	All Day	• Respirators not required • Continue Work • Routine Monitoring
5-20 ppm	0-15 Minutes	• Respirators not required • Continue Work • Increase Monitoring
5-20 ppm	>15 Minutes	• Don Respirators • Continue Work • Continue Monitoring
5-50 ppm	All Day	• Wear Respirators • Continue Work • Increased Monitoring
>50 ppm	Any	• Stop Work • Leave Area

8.0 SITE CONTROL/DECONTAMINATION

It is anticipated that access to the site will be limited through use of temporary fencing, barrier tape and warning signs.

8.1 Work Zones

The following work zones will be established and clearly delineated through use of signs, tape or other temporary barriers.

- Clean Zone/Support Zone

  This uncontaminated support zone or clean zone will be the area outside the exclusion and decontamination zones and within the geographic perimeters of the site. This area is used for staging of materials, parking of vehicles, office and laboratory facilities, sanitation facilities and receipt of deliveries. Personnel entering this zone may include delivery personnel, visitors, security guards, etc., who will not necessarily be permitted in the exclusion zone. All personnel arriving in the support zone will upon arrival, report to the command post and sign the site entry/exit log. There will be one controlled entry/exit point from the clean zone to the decontamination zone.

- Decontamination Zone

The decontamination zone will provide a location for removal of contaminated personal protective equipment and final decontamination of personnel and equipment. Suitable containers will be provided for disposal of contaminated disposable clothing. All personnel and equipment should exit via the decon area. A separate decontamination area will be established for heavy equipment.

- Exclusion Zone/Hot Zone

The exclusion zone will be the "hot-zone" or contaminated area inside the site perimeter. **Entry to and exit from this zone will be made through a designated point and all personnel will be required to sign the hot zone entry/exit log located at the decon area.** Appropriate warning signs to identify the exclusion zone will be posted (i.e. "DANGER - AUTHORIZED PERSONNEL ONLY", "PROTECTIVE EQUIPMENT REQUIRED BEYOND THIS POINT", etc.). Exit from the exclusion zone must be accompanied by personnel and equipment decontamination as described in Section 8.2.

8.2 Decontamination

- Personnel Decontamination

Disposable contaminated clothing should be removed in the decontamination zone and disposed of in the containers provided for this purpose.

Reusable outer clothing should be brushed free of gross soil contamination. Reusable outer boots should be thoroughly washed and rinsed before leaving the decon area.

- *Decontamination of Hand Tools*

  Hand tools will be washed with water to remove gross contamination and thoroughly rinsed.

Heavy Equipment Decontamination

Prior to leaving the site, the undercarriage, wheels, tracks and other heavy equipment parts in contact with contaminated soil, groundwater or waste materials will be steam cleaned.

9.0 EMERGENCY PROCEDURES

9.1 Emergency Contacts

Facility/Agency	Phone Number
Ambulance	911
Fire	911
Concord Township Fire Station (Business)	875-5920
Police	911
Sheriff	911
Hospital-Elkhart General	
600 East Boulevard	294-2621
State Emergency Response	(317)243-5176
National Response Center	(800)424-8802
Poison Control Center	(800)382-9097

9.2 Directions to Hospital

Industrial Parkway west and south to Middlebury Street. West on Middlebury to Main. North on Main to U.S. 20 (Jackson and Lexington). West on 20 to East Boulevard. South on East Boulevard to river.

9.3 List of Emergency Equipment

The following emergency equipment is available at the site.

Communications Equipment	Location
Telephones	Support Zone
Two-Way Radios	As needed
Medical Equipment	
First Aid Kits	Support Zone/Exclusion Zone
Eye Wash Station	Exclusion Zone
Fire Fighting	
Fire Extinguishers	Exclusion Zone/Support Zone

9.4 Worker Injury

Any person who becomes ill or injured in the exclusion zone must be decontaminated to the maximum extent possible. If the injury of illness is minor, full decontamination should be completed and first aid administered prior to transport. If the patient's condition is serious, at least partial decontamination should be completed (i.e., complete disrobing of the victim and redressing in clean coveralls or wrapping in a blanket). First aid should be administered while awaiting an ambulance or paramedics. All injuries and illnesses must immediately be reported to the Engineering Manager.

Any person transporting an injured/exposed person to a clinic or hospital for treatment should take with them directions to the hospital and information on the chemical(s) they may have been exposed to.

9.5 Personal Protective Equipment Failure

If a site worker should experience a failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately leave the working area. Re-entry shall not be permitted until the equipment has been repaired or replaced.

9.6 Other Equipment Failure

If any of the equipment on-site fails to operate properly, the Engineering Manager will be notified and the effect of this failure on continuing operations will be determined. If the failure effects the safety of personnel or prevents completion of the work plan tasks, all personnel will leave the area until the situation is evaluated and appropriate actions performed.

9.7 Fire/Explosion

In the event of a fire beyond the incipient stage or an explosion, the fire department will be contacted immediately. Personnel shall move to a safe distance from the affected area. The Engineering Manager or his designee shall direct fire equipment arriving at the scene to the involved area and advise response personnel of the nature and types of hazardous materials on site. Site personnel may attempt to extinguish small incipient stage fires and move or isolate flammable or other hazardous materials which may contribute to the fire.

9.8 Spills or Leaks

In the event of a spill or a leak, employees will:

- Locate the source of the spillage and stop the flow if it can be done safely.
- Begin containment and recovery of the spilled materials.
- Arrange for cleanup of the area.

9.9 Weather Emergencies

In the event of heavy weather, the Engineering Manager or a site supervisor will oversee the securing of the site, materials and equipment in order to prevent the loss or migration of hazardous materials from the site and to prevent public access to the site.

9.10 Evacuation Routes and Procedures

Evacuation routes will be established by work area locations for this site. Site personnel will be informed prior to any changes in evacuation routes or procedures.

Evacuation notification will be a continuous blast on an air horn, vehicle horn, or by verbal communication via radio.

The following general procedures will be followed if evacuation of the site is necessary.

- Keep upwind of smoke, vapors or spill location.

- Decontaminate to the maximum extent possible.

- Exit through the decontamination corridor if possible.

- If evacuation is not via the decontamination corridor, site personnel should remove contaminated clothing once they are in a location of safety and leave it near the exclusion zone or in a safe place.

- Meet at the Support Zone or otherwise designated area.

- The Engineering Manager will conduct a head count to insure all personnel have been evacuated safely.

9.11 Re-entry Procedures

When an on-site emergency results in evacuation, personnel shall not re-enter until:

- The conditions resulting in the emergency have been corrected.

- The hazards have been reassessed.

- The Site Safety Plan has been reviewed.

- Site personnel have been briefed on any changes in the Site Safety Plan.

10.0 CONFINED SPACE ENTRY

Confined space entry is not anticipated during Field Design Activities.

APPENDIX A

SITE SAFETY PLAN AMENDMENTS

SITE SAFETY PLAN AMENDMENT #_____:_____SITE NAME:

DATE: _____

REASON FOR AMENDMENT:_____

_____

_____

_____

ALTERNATE SAFEGUARD PROCEDURES:_____

_____

_____

_____

_____

REQUIRED CHANGES IN PPE:_____

_____

_____

_____

_____ _____ _____ _____

EIS ENGINEERING MANAGER (Date) EIS SITE SAFETY OFFICER (Date)

APPENDIX B

SITE SAFETY PLAN ACKNOWLEDGMENT

SITE SAFETY PLAN ACKNOWLEDGMENT FORM

I have been informed and understand and will abide by the procedures set forth in the Safety and Health Plan and Amendments for the _____ site.

Printed Name	Signature	Representing	Date

APPENDIX C
COLD STRESS

COLD STRESS

The cold stress TLVs are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities (deep body temperature is the core temperature of the body determined by conventional methods for rectal temperature measurements). For a single, occasional exposure to a cold environment, a drop in core temperature to no lower that 35°C (95°F) should be permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body with emphasis on hands, feet, and head from cold injury.

Introduction

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. The clinical presentations of victims of hypothermia are shown in Table 1. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F); lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 35°C (95°F). This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Since prolonged exposure to cold air, or to immersion in cold water, at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided.

1 Adequate insulating dry clothing to maintain core temperatures above 36°C (96.8°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Wind chill cooling rate and the cooling power of air are critical factors. [Wind chill cooling rate is defined as heat loss from a body expressed in watts per meter squared which is a function of the air temperature and wind velocity upon the exposed body.] The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required. An equivalent chill temperature chart relating the actual dry bulb air temperature and the wind velocity is presented in Table 2. The equivalent chill temperature

TABLE 1. Progressive Clinical Presentations of Hypothermia*

Core Temperature °C	Core Temperature °F	Clinical Signs
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32 / 31	89.6 / 87.8	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
30 / 29	86.0 / 84.2	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
28	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent
26	78.8	Victim seldom conscious
25	77.0	Ventricular fibrillation may occur spontaneously
24	75.2	Pulmonary edema
22 / 21	71.6 / 69.8	Maximum risk of ventricular fibrilation
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of *American Family Physician*, published by the American Academy of Family Physicians.

TABLE 2. Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F) 50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* In < hr with dry skin. Maximum danger of false sense of security					*INCREASING DANGER* Danger from freezing of exposed flesh within one minute.			*GREAT DANGER* Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

should be used when estimating the combined cooling effect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the deep body core temperature.

2. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions which should be considered. The precautionary actions to be taken will depend upon the physical condition of the worker and should be determined with the advice of a physician with knowledge of the cold stress factors and the medical condition of the worker.

Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of −32°C (−25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below −1°C (30.2°F) regardless of wind speed.

At air temperatures of 2°C (35.6°F) or less, it is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and be treated for hypothermia.

TLVs recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 3.

Special protection of the hands is required to maintain *manual dexterity for the prevention of accidents:*

1. If fine work is to be performed with bare hands for more than 10–20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars should be covered by thermal insulating material at temperatures below −1°C (30.2°F).
2. If the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, −7°C (19.4°F) for moderate work and *fine manual dexterity is not required*, then gloves should be used by the workers.

To prevent contact frostbite, the workers should wear anti-contact gloves.

1. When cold surfaces below −7°C (19.4°F) are within reach, a warning should be given to each worker by the supervisor to prevent inadvertent contact by bare skin.
2. If the air temperature is −17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers should wear cold protective clothing appropriate for the level of cold and physical activity:

1. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment.
2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outerwear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, the employee should make sure that clothing is not wet as a consequence of sweating. If clothing is wet, the employee should change into dry clothes before entering the cold area. The workers should change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change should be determined empirically and will vary individually and according to the type of shoe worn and how much the individual's feet sweat.
3. If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items should be supplied in auxiliary heated versions.
4. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work should be modified or suspended until adequate clothing is made available or until weather conditions improve.
5. Workers handling evaporative liquid (gasoline, alcohol or cleaning fluids) at air temperatures below 4°C (39.2°F) should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point that is just above ambient temperature.

Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below −7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms, etc.) should be made available nearby. The workers should be encouraged to use these shelters at regular intervals, the frequency depending on the

TABLE 3. Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift*

Air Temperature – Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

Notes for Table 3:

†1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m²; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m². In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

* Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing should be provided as necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below −12°C (10.4°F) ECT, the following should apply:

1. The worker should be under constant protective observation (buddy system or supervision).
2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods should be taken in heated shelters and opportunity for changing into dry clothing should be provided.
3. New employees should not be required to work fulltime in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
4. The weight and bulkiness of clothing should be included in estimating the required work performance and weights to be lifted by the worker.
5. The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.
6. The workers should be instructed in safety and health procedures. The training program should include as a minimum instruction in:
   a. Proper rewarming procedures and appropriate first aid treatment.
   b. Proper clothing practices.
   c. Proper eating and drinking habits.
   d. Recognition of impending frostbite.
   e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
   f. Safe work practices.

Special Workplace Recommendations

Special design requirements for refrigerator rooms include the following:

1. In refrigerator rooms, the air velocity should be minimized as much as possible and should not exceed 1 meter/sec (200 fpm) at the job site. This can be achieved by properly designed air distribution systems.
2. Special wind protective clothing should be provided based upon existing air velocities to which workers are exposed.

Special caution should be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits.

Eye protection for workers employed out-of-doors in a snow and/or ice-covered terrain should be supplied. Special safety goggles to protect against ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) and blowing ice crystals should be required when there is an expanse of snow coverage causing a potential eye exposure hazard.

Workplace monitoring is required as follows:

1. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16°C (60.8°F) so that overall compliance with the requirements of the TLV can be maintained.
2. Whenever the air temperature at a workplace falls below −1°C (30.2°F), the dry bulb temperature should be measured and recorded at least every 4 hours.
3. In indoor workplaces, the wind speed should also be recorded at least every 4 hours whenever the rate of air movement exceeds 2 meters per second (5 mph).
4. In outdoor work situations, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below −1°C (30.2°F).
5. The equivalent chill temperature should be obtained from Table 2 in all cases where air movement measurements are required; it should be recorded with the other data whenever the equivalent chill temperature is below −7°C (19.4°F).

Employees should be excluded from work in cold at −1°C (30.2°F) or below if they are suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to temperatures below −24°C (−11.2°F) with wind speeds less than five miles per hour, or air temperatures below −18°C (0°F) with wind speeds above five miles per hour, should be medically certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to cold injury. Special provisions should be made to prevent hypothermia and freezing of damaged tissues in addition to providing for first aid treatment.

APPENDIX D

HEAT STRESS

HEAT STRESS

The heat stress TLVs specified in Table 1 and Figure 1 refer to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. These TLVs are based on the assumption that nearly all acclimatized, fully clothed (e.g., lightweight pants and shirt) workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C (100.4°F).

*Where there is a requirement for protection against other harmful substances in the work environment and additional personal protective clothing and equipment must be worn, a correction to the WBGT TLV values, as presented in Table 4, must be applied.

Since measurement of deep body temperature is impractical for monitoring the workers' heat load, the measurement of environmental factors is required which most nearly correlate with deep body temperature and other physiological responses to heat. At the present time, the Wet Bulb Globe Temperature Index (WBGT) is the simplest and most suitable technique to measure the environmental factors. WBGT values are calculated by the following equations:

1. Outdoors with solar load:
   WBGT = 0.7 NWB + 0.2 GT + 0.1 DB
2. Indoors or Outdoors with no solar load:
   WBGT = 0.7 NWB + 0.3 GT

where:

WBGT = Wet Bulb Globe Temperature Index
NWB = Natural Wet-Bulb Temperature
DB = Dry-Bulb Temperature
GT = Globe Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer.

Higher heat exposures than those shown in Table 1 and Figure 1 are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38°C (100.4°F).

Evaluation and Control

1. *Measurement of the Environment*

The instruments required are a dry-bulb, a natural wet-bulb, a globe thermometer, and a stand. The measurement of the environmental factors should be performed as follows:

A. The range of the dry and the natural wet bulb thermometer should be −5°C to +50°C (23°F to 122°F) with an accuracy of ± 0.5°C. The dry bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer should be kept wet with distilled water for at least 1/2 hour before the temperature reading is made. It is not enough to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillarity. The wick should be wetted by direct application of water from a syringe 1/2 hour before each reading. The wick should extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and new wicks should be washed before using.

B. A globe thermometer, consisting of a 15-cm (6-inch) diameter hollow copper sphere painted on the outside with a matte black finish or equivalent, should be used. The bulb or sensor of a thermometer (range −5°C to +100°C [23°F to 212°F] with an accuracy of ± 0.5°C) must be fixed in the center of the sphere. The globe thermometer should be exposed at least 25 minutes before it is read.

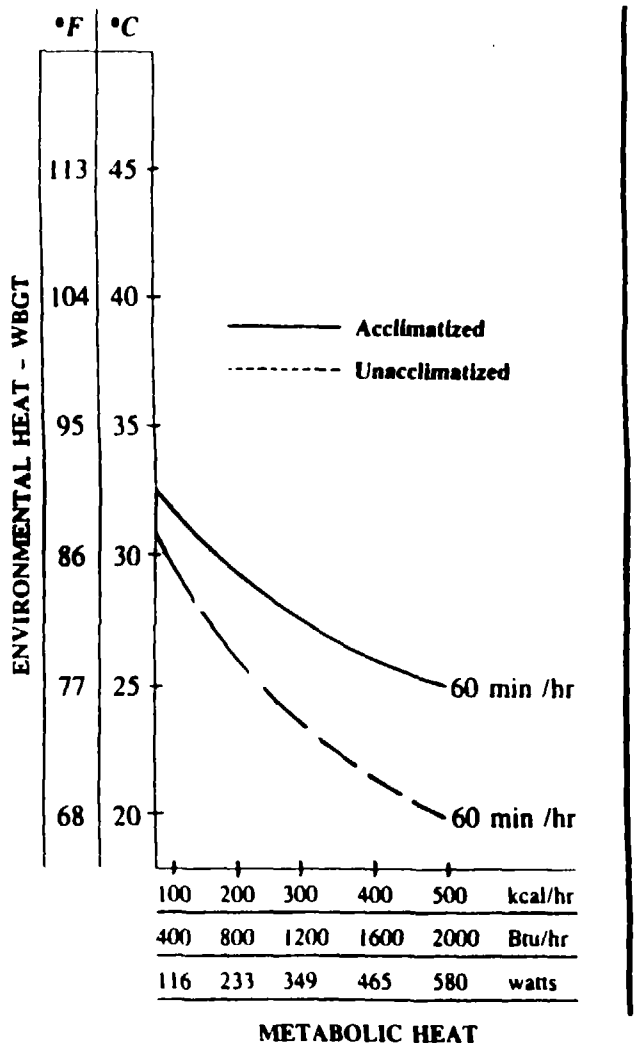
C. A stand should be used to suspend the three thermometers so that they do not restrict free air flow around the bulbs, and the wet-bulb and globe thermometer are not shaded.

D. It is permissible to use any other type of temperature sensor

TABLE 1. Examples of Permissible Heat Exposure Threshold Limit Values [Values are given in °C and (°F) WBGT]*

	Work Load		
Work—Rest Regimen	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% Work — 25% Rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% Work — 50% Rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% Work — 75% Rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

* As workload increases, the heat stress impact on an unacclimatized worker is exacerbated (see Figure 1). For unacclimatized workers performing a moderate level of work, the permissible heat exposure TLV should be reduced by approximately 2.5°C.



†Figure 1 — Permissible heat exposure Threshold Limit Values for heat acclimatized and unacclimatized workers.

that gives a reading identical to that of a mercury thermometer under the same conditions.

E. The thermometers must be placed so that the readings are representative of the conditions under which the employees work or rest, respectively.

II. *Work Load Categories*

Heat produced by the body and the environmental heat together determine the total heat load. Therefore, if work is to be performed under hot environmental conditions, the workload category of each job should be established and the heat exposure limit pertinent to the workload evaluated against the applicable standard in order to protect the worker exposure beyond the permissible limit.

A. The work load category may be established by ranking each job into light, medium, or heavy categories on the basis of type of operation:

(1) light work (up to 200 kcal/hr or 800 Btu/hr): e.g., sitting or standing to control machines, performing light hand or arm work,

(2) moderate work (200–350 kcal/hr or 800–1400 Btu/hr): e.g., walking about with moderate lifting and pushing, or

(3) heavy work (350–500 kcal/hr or 1400–2000 Btu/hr): e.g., pick and shovel work.

Where the work load is ranked into one of said three categories, the permissible heat exposure TLV for each workload can be estimated from Table 1 or calculated using Tables 2 and 3.

B. The ranking of the job may be performed either by measuring the worker's metabolic rate while performing a job or by estimating the worker's metabolic rate with the use of Tables 2 and 3. Additional tables available in the literature[1-4] may be utilized also. When this method is used, the permissible heat exposure TLV can be determined by Figure 1.

III. *Work–Rest Regimen*

The TLVs specified in Table 1 and Figure 1 are based on the assumption that the WBGT value of the resting place is the same or very close to that of the workplace. Where the WBGT of the work area is different from that of the rest area, a time-weighted average value should be used for both environmental and metabolic heat.

The time-weighted average metabolic rate (M) should be determined by the equation:

$$\text{Av. } M = \frac{M_1 \times t_1 + M_2 \times t_2 + \ldots + M_n \times t_n}{t_1 + t_2 + \ldots + t_n}$$

where M_1, M_2...and M_n are estimated or measured metabolic

TABLE 2. Assessment of Work Load

Average values of metabolic rate during different activities.

A. Body position and movement	kcal/min
Sitting	0.3
Standing	0.6
Walking	2.0-3.0
Walking up hill	add 0.8 per meter (yard) rise

B. Type of Work		Average kcal/min	Range kcal/min
Hand work	*light*	0.4	0.2-1.2
	heavy	0.9	
Work with one arm	*light*	1.0	0.7-2.5
	heavy	1.7	
Work with both arms	*light*	1.5	1.0-3.5
	heavy	2.5	
Work with body	*light*	3.5	2.5-15.0
	moderate	5.0	
	heavy	7.0	
	very heavy	9.0	

rates for the various activities and rest periods of the worker during the time periods t_1, t_2... and t_n (in minutes) as determined by a time study.

The time-weighted average WBGT should be determined by the equation:

$$\text{Av. WGBT} = \frac{WBGT_1 \times t_1 + WBGT_2 \times t_2 + \ldots + WBGT_n \times t_n}{t_1 + t_2 + \ldots + t_n}$$

where $WBGT_1$, $WBGT_2$ ... and $WBGT_n$ are calculated values of WBGT for the various work and rest areas occupied during total time periods; t_1, t_2 ... and t_n are the elapsed times in minutes spent in the corresponding areas which are determined by a time study. Where exposure to hot environmental conditions is continuous for several hours or the entire work day, the time-weighted averages should be calculated as an hourly time-weighted average, i.e., $t_1 + t_2 + \ldots t_n = 60$ minutes. Where the exposure is inter-

mittent, the time-weighted averages should be calculated as two-hour time-weighted averages, i.e., $t_1 + t_2 + \ldots + t_n = 120$ minutes.

The TLVs for continuous work are applicable where there is a work–rest regimen of a 5-day work week and an 8-hour work day with a short morning and afternoon break (approximately 15 minutes) and a longer lunch break (approximately 30 minutes). Higher exposure values are permitted if additional resting time is allowed. All breaks, including unscheduled pauses and administrative or operational waiting periods during work, may be counted as rest time when additional rest allowance must be given because of high environmental temperatures.

IV. *Water and Salt Supplementation*

During the hot season or when the worker is exposed to artificially generated heat, drinking water should be made available to the workers in such a way that they are stimulated to frequently drink small amounts, i.e., one cup every 15–20 minutes (about 150 ml or 1/4 pint).

The water should be kept reasonably cool, 10°C to 15°C (50°F to 60°F) and should be placed close to the workplace so that the worker can reach it without abandoning the work area.

The workers should be encouraged to salt their food well during the hot season and particularly during hot spells. If the workers are unacclimatized, salted drinking water should be made available in a concentration of 0.1% (1 g NaCl to 1.0 liter or 1 level tablespoon of salt to 15 quarts of water). The added salt should be completely dissolved before the water is distributed, and the water should be kept reasonably cool.

TABLE 3. Activity Examples

- **Light hand work: writing, hand knitting**
- **Heavy hand work: typewriting**
- Heavy work with one arm: hammering in nails (shoemaker, upholsterer)
- Light work with two arms: filing metal, planing wood, raking of a garden
- Moderate work with the body: cleaning a floor, beating a carpet
- Heavy work with the body: railroad track laying, digging, barking trees

Sample Calculation

Assembly line work using a heavy hand tool.

A.	Walking along	2.0 kcal/min
B.	Intermediate value between heavy work with two arms and light work with the body	3.0 kcal/min
	Subtotal:	5.0 kcal/min
C.	Add for basal metabolism	1.0 kcal/min
	Total:	6.0 kcal/min

***TABLE 4. TLV WBGT Correction Factors in °C for Clothing**

Clothing Type	Clo Value*	WBGT Correction
Summer work uniform	0.6	0
Cotton coveralls	1.0	-2
Winter work uniform	1.4	-4
Water barrier, permeable	1.2	-6

*Clo: Insulation value of clothing. One clo unit = 5.55 kcal/m²/hr of heat exchange by radiation and convection for each °C of temperature difference between the skin and adjusted dry bulb temperature.

V. *Other Considerations*

A. *Clothing:* The permissible heat exposure TLVs are valid for light summer clothing as customarily worn by workers when working under hot environmental conditions. If special clothing is required for performing a particular job and this clothing is heavier or it impedes sweat evaporation or has higher insulation value, the worker's heat tolerance is reduced, and the permissible heat exposure TLVs indicated in Table 1 and Figure 1 are not applicable. For each job category where special clothing is required, the permissible heat exposure TLV should be established by an expert.

Table 4 identifies TLV WBGT correction factors for representative types of clothing.

B. *Acclimatization and Fitness:* Acclimatization to heat involves a series of physiological and psychological adjustments that occur in an individual during the first week of exposure to hot environmental conditions. The recommended heat stress TLVs are valid for acclimated workers who are physically fit. Extra caution must be employed when unacclimated or physically unfit workers must be exposed to heat stress conditions.

C. *Adverse Health Effects:* The most serious of heat-induced illnesses is heat stroke because of its potential to be life threatening or result in irreversible damage. Other heat-induced illnesses include heat exhaustion which in its most serious form leads to prostration and can cause serious injuries as well. Heat cramps, while debilitating, are easily reversible if properly and promptly treated. Heat disorders due to excessive heat exposure include electrolyte imbalance, dehydration, skin rashes, heat edema, and loss of physical and mental work capacity.

If during the first trimester of pregnancy, a female worker's core temperature exceeds 39°C (102.2°F) for extended periods, there is an increased risk of malformation to the unborn fetus. Additionally, core temperatures above 38°C (100.4°F) may be associated with temporary infertility in both females and males.

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